

SCIENCE | TECHNOLOGY | FUTURE

FOCUS

HOW
SOCIAL
NETWORKS
MAKE US
ANTISOCIAL

*Plus***THE GENETIC
GOLDRUSH**

What companies want
with your DNA

WHY WE NEED TO GO

**BACK
TO THE
MOON**

How a new lunar mission
would change life on Earth

WITH CHRIS HADFIELD**FIND OUT**

WHY THE SEA
SMELLS LIKE THE SEA

**HOW SLEEP AND
ANAESTHESIA DIFFER**

WHY ELEPHANTS
NEVER FORGET

#306 | £4.50 April 2017 sciencefocus.com



9 770966 427159

THE 500-YEAR QUEST TO MAKE MACHINES HUMAN

'Bold and compelling'
The Times

'Unmissable'
City AM

Until 3 September 2017

Open until 22.00 every Friday

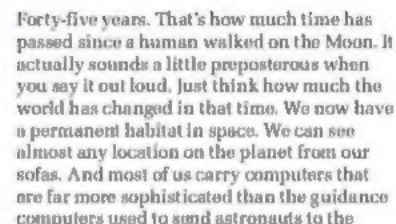
sciencemuseum.org.uk/robots

ScienceMuseum #Robots

Executive Partner

theguardian

WELCOME



Moon. Yet because of the cost, we've never gone back.

But it seems now there's a new surge of interest in returning to the Moon. PayPal and Tesla founder Elon Musk is offering a lunar flyby for space tourists next year, while NASA has suggested it could send its Orion spacecraft to the Moon as a dry run for Mars. So what will we actually gain by revisiting our neighbour? We put this question to an astronaut, a businessman, a philosopher, a biologist and a geologist to find out (p.38).

This month, *Stargazing Live* returns! This time, Brian Cox and Dara O Briain will be ogling the jewels of the night sky live from Australia. But if you want to get a deeper understanding of how the cosmos works, then look no further. In this issue, Brian Cox and Jeff Forshaw kick off a new four-part series in which they elegantly unravel the fundamental fabric of our Universe (p64). Don't miss it.

Daniel Bennett, Editor

BRIAN COX

Physicist Brian is a familiar face on our TV screens. He joins Jeff Forshaw to demystify our Universe in the first part of our new series. **→p54**



JEFF FURSHMAN
Physicist Jeff works with Brian and has acted as consultant on several BBC shows. He's the ideal person to help us unravel the cosmos. → p64



With a background in genetics and developmental biology, Kat is just the expert to investigate the world of genetic test kits. → p58

Selfie-editing
has been linked
with narcissism
→ p56



If you were travelling at close to light speed, you would get to Andromeda in 50 years → p68



Shiny hair can teach us about the roughness of the sea → p73



Kangaroos can produce milk of different types from their teats
→ p78

Advertising

neil.lloyd@immediate.co.uk
0117 300 8276

✉ Letters for publication
reply@sciencefocus.com

Editorial Enquiries
editorialenquiries@routledge.com

0117 314 7388
 ● Subscriptions

focus@servicehelpline.co.uk
0344 844 0357*

Other contacts
science@pcys.com/contact

WANT MORE?
FOLLOW
SCIENCEFOCUS

F **FACEBOOK**

 TWITTER PINTEREST

CONTENTS

29



REGULARS

6 Eye opener

Stunning images from around the world.

13 Discoveries

All of the month's biggest science news.

27 Innovations

The Range Rover Velar, must-have gadgets and the new BlackBerry.

35 Reply

Your letters and emails.

73 Helen Czerski

On sunshine, the sea and split ends.

75 Q&A

This month, why is the human brain so big, what is the deepest lake on Earth, do elephants really never forget, what's the dodo's closest surviving relative, and more.

88 Out there

The best books, TV shows and days out.

94 Crossword

Our tricky science-themed crossword will get your grey matter churning.

98 My life scientific

Helen Pitcher talks to forensic psychologist and author Kerry Daynes.

56 Subscribe

Save 40% on the cover price when you subscribe today!

38



64

FEATURES

Back to the Moon

38 A human last set foot on the Moon in December 1972. Five scientists explain why it would be a good idea to go back there soon.

Antisocial network

50 Do social networks do what they say on the tin, or are they actually making us more antisocial? Neuroscientist Dr Dean Burnett examines the evidence.

The genetic goldrush

58 Apps and services offering DNA-based advice on everything from planning a workout to choosing a wine are increasingly common. Kat Arney finds out more.

Jeff Forshaw and Brian Cox's guide to the cosmos

64 In Part 1 of our new series, Brian Cox and physicist Jeff Forshaw ponder the baffling idiosyncrasies of the space-time continuum.

58



50



EYE OPENER

It takes two to tango

BUENOS AIRES,
ARGENTINA

Painted in the colours of the Argentine capital's two most famous football teams – River Plate in red and white, and Boca Juniors in yellow and blue – DevBot 1 and 2 race through the city's streets.

The driverless electric cars, developed by Roborace, need to communicate with each other and continually scan their environment to avoid collision. "It is so exciting to see these vehicles taking appropriate actions in order to guide themselves around the track," says Roborace CEO Denis Sytykh.

Roborace hosts the first global championship for driverless cars, and this race on 18 February, watched by cheering crowds, was the first ever display of two autonomous cars on a race course at the same time. Unfortunately, an unexpected living competitor swerved DevBot 1 and 2 off their course: a dog caught up in the excitement broke through the barriers, which ended one car's race with a crash. Thankfully the cars' systems were advanced enough to avoid the canine intruder completely.

PHOTO: ROBORACE





EYE OPENER

Feeding frenzy

**SHETLAND ISLES,
SCOTLAND**

For gannets, dinner can quickly turn into a fierce battle. These duelling seabirds brave the turbulent waters of the North Sea to dive for mackerel thrown overboard by the photographer. They need to be fast: once the food source becomes widely known, it's every gannet for itself.

"Gannets are masters of flight, but they're also efficient hunters below the water," says Dr Ewan Wakefield, a biologist at the University of Glasgow. "They have eyes which function well above and below water, and bodies protected by air sacs which can compress on impact with water, allowing them to plunge dive into the sea."

"Gannets from different colonies tend to forage in mutually exclusive areas," he continues. "If a bird has flown a smaller distance, it's going to be in better condition than a bird from a more distant colony."

PHOTO: RICHARD SHUCKSMITH/NPL

A large bonfire of seized firearms in Nairobi, Kenya. The image shows a massive pile of rifles and handguns, some of which are already on fire. The fire is intense, with bright orange and yellow flames rising from the pile. The background is a hazy, overcast sky. The overall scene is one of destruction and disposal of illegal weapons.

EYE OPENER

All fired up

NAIROBI,
KENYA

In November last year, some 5,250 seized firearms were arranged into three 4.5m-high piles, before being doused with fuel and set alight by Kenyan authorities. The bonfire, which took place near Nairobi, was attended by the country's deputy president William Ruto. It is hoped that the blaze will deter people from owning firearms and encourage others to surrender their weapons.

Kenyan gun laws are strict, and residents have to go through a number of controls and checks to own a firearm. Despite this, hundreds of guns are smuggled into the country each year, particularly via the border with neighbouring Somalia. It is estimated that around half a million guns are illegally held by civilians in Kenya, and are used for poaching, robberies and extremist violence.

PHOTO: CAMERA PRESS/DAI KUROWAKA

100% RENEWABLE ELECTRICITY AND GREEN GAS

We've always supplied 100% renewable electricity, now we supply gas that does good too.

Choosing Good Energy for electricity and gas could reduce your personal carbon footprint by up to 50%.

Just some of the reasons we're ranked by Ethical Consumer as their No.1 green electricity supplier.

Switch to kinder, greener, local energy for less than you think.

Quote
'FOC0317'
when you switch
to receive a
£50 John Lewis
gift card

Call **0800 254 0000**
goodenergy.co.uk/fo

Offer ends 30/06/2017

For full details of how we source our electricity
visit: goodenergy.co.uk/source
Calculations visit: goodenergy.co.uk/goodstats
Green gas visit: goodenergy.co.uk/green-gas
Gift card incentive terms visit: goodenergy.co.uk/terms-conditions

good energy

DISCOVERIES

DISPATCHES FROM THE CUTTING EDGE

APRIL 2017

EDITED BY JASON GOODYER



SPACE

SEVEN EARTH-SIZED EXOPLANETS FOUND

The system of planets found orbiting nearby dwarf star TRAPPIST-1 may be our best chance yet of finding alien life

TRAPPIST-1, an ultracool dwarf star located just 40 light-years from Earth in the Aquarius constellation, was first detected by researchers from Liege using the Transiting Planets and Planetesimals Small Telescope (TRAPPIST) in Chile, and later confirmed by NASA's Spitzer Space Telescope and the Very Large Telescope, also in Chile.

The planets were detected by observing dips in the star's light output caused by each of the seven planets passing in front of it, events known as transits.

The researchers found that all of the planets are comparable in size to the Earth, while density measurements suggest that the innermost six are rocky.

Current climate models suggest the three innermost planets are probably too hot to support liquid water, and the one furthest from the star is too cold. However, the remaining three sit comfortably within the habitable zone and could host oceans of surface water – a feature thought to be essential for the existence of life.

"The energy output from dwarf stars like TRAPPIST-1 is much weaker than that of our Sun. Planets would need to be in far closer orbits than we see in the Solar System if there is to be surface water," said researcher Dr Amaury Triaud. "Fortunately, it seems that this kind of compact configuration is just what we see around TRAPPIST-1."

PHOTO: NASA



As the planets in the TRAPPIST-1 system are so close together, they'd be visible in each other's skies, as seen in this illustration

EXPERT COMMENT

The star is relatively small, just 8 per cent the mass of the Sun, and would appear to glow salmon pink when observed from the surface of the planets, the researchers say.

Now that astronomers know that the planets are there, the next job is to find out what they are really like. The first step is to make an accurate determination of their densities. When searching for habitable worlds, rocky planets are the clear preference because – put simply – they provide a surface for life forms to walk, slither or otherwise move across.

The European Space Agency (ESA) will launch CHEOPS (CHAracterising ExOPlanet Satellite) in 2018. The main science goal of the mission is to measure the densities of planets with radii between one and six times of Earth. The TRAPPIST-1 system will be high on the list.

The next step will be to analyse the planets' atmospheres to see if any look like they could be habitable. "The main goal will be trying to detect the signature of water," said CHEOPS scientist Dr Vincent Bourrier.

Water vapour in a planet's atmosphere could betray widespread oceans and a water cycle. Its signature appears in the infrared region of the spectrum and this is where the NASA-built James Webb Space Telescope (JWST) comes in.

ESA will launch the JWST in the same year as CHEOPS. With its 6.5m-diameter infrared mirror, JWST will make analysing exoplanet atmospheres easier than ever. One of its first targets is likely to be the seven worlds of the TRAPPIST-1 solar system.

"ROCKY PLANETS ARE THE CLEAR PREFERENCE BECAUSE THEY PROVIDE A SURFACE FOR LIFE FORMS"

While finding water vapour would increase the belief that the planet under investigation is potentially habitable, there are other factors that could affect a planet's ability to support life.

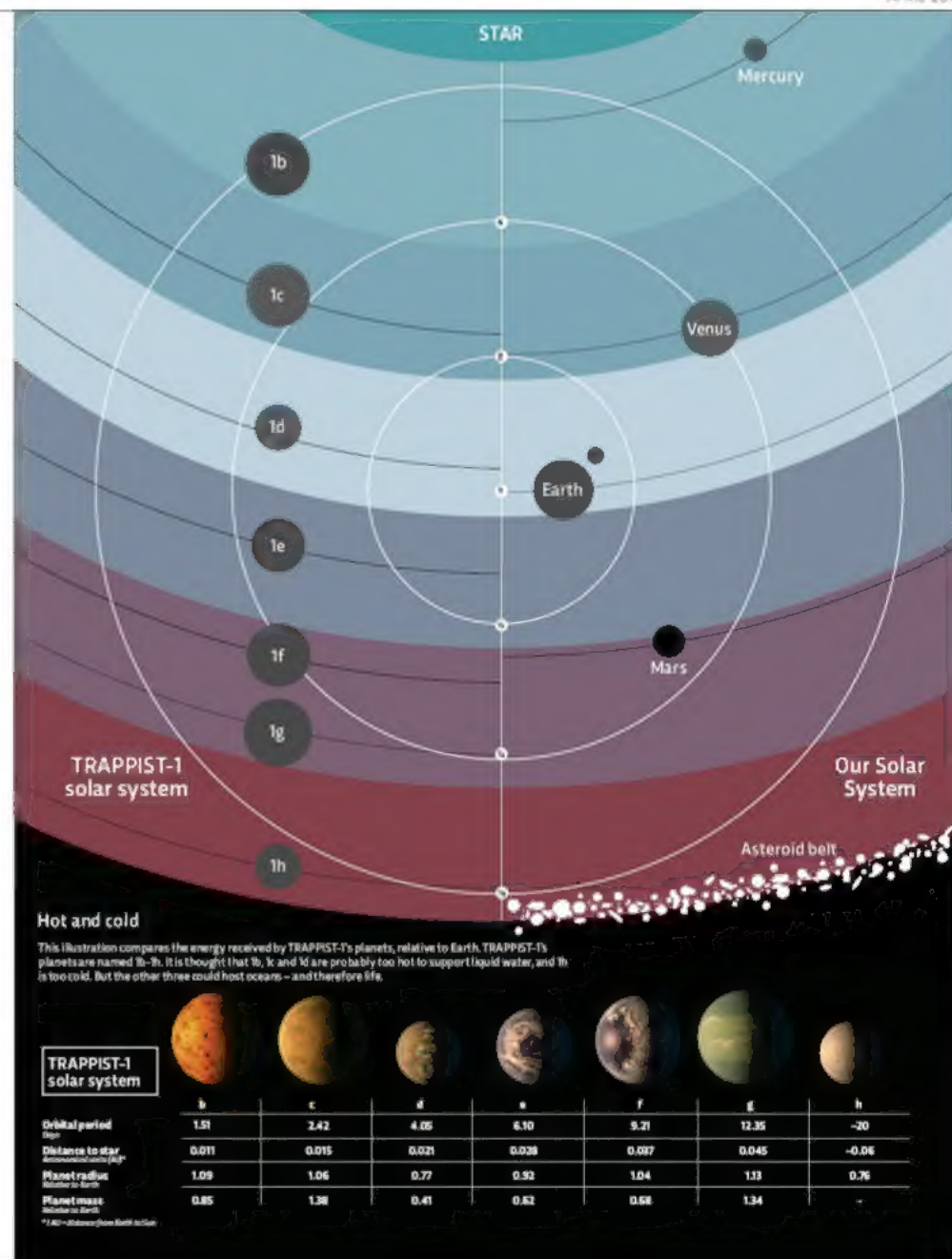
To investigate those, Bourrier and his team have already used the Hubble Space Telescope to look at the ultraviolet signature of TRAPPIST-1's two innermost planets. His work shows that those planets could have had their atmospheres completely eroded away by the radiation from the star – rendering the planets barren. Could this have happened to the other worlds of TRAPPIST-1?

Actually proving that a planet is habitable may be really tough. Astronomers will have to look for 'biomarkers'. These are gases that only exist together in an atmosphere because they are being replenished by the metabolisms of living creatures. Oxygen and methane are good examples in our own atmosphere. So far, there are no firm plans to build a space telescope capable of making such an exacting measurement, although NASA and ESA have both studied engineering concepts.

NASA's next exoplanet mission, the Transiting Exoplanet Survey Satellite (TESS), also launching next year, could reveal many more solar systems like TRAPPIST-1. This mission will survey 200,000 stars and is expected to discover thousands of exoplanets, from the size of Earth up to Jupiter and larger.

Stuart Clark is an astronomy writer. His most recent book is *The Search For Earth's Twin* (E20, Quercus).

PHOTOS: NASA/ESA



THE DOWNLOAD

HANDLE

What's so interesting about handles?

Ah, not handle but Handle – the latest robotic creation to come out of the Boston Dynamics development labs.

Hang on. Who are Boston Dynamics?

An engineering and robotics design company based in the US who are responsible for the impressive walking robots such as Big Dog and Atlas.

Right. What's so special about Handle then?

As it has a combination of both wheels and legs, it can travel over varied terrain. It has a top speed of 14km/h (9mph), it can make vertical jumps of up to 120cm and can pick up and carry loads as heavy as 50kg. It's also able to travel up to 24km on a single battery charge.

Impressive. So what can it be used for?

So far Handle is just being used for R and D purposes, but the future uses could range from everything from unloading lorries to search and rescue.



Boston Dynamics' rolling, jumping robot

ZOOLOGY

FOOTBALLING BEES SHED NEW LIGHT ON INSECT INTELLIGENCE

We bet these guys are good on the wing: bumblebees have been taught to play football by a team at Queen Mary University of London.

The team trained the bees to dribble a ball into a round goal in three different ways: some observed a previously trained bee scoring a goal, some watched the ball being moved into the goal by a magnet, and others simply 'found' the ball in the goal. The bees

were rewarded with a sugary treat for a successful 'shot'.

Of the three, those observing other bees learnt the quickest.

"Our study puts the final nail in the coffin of the idea that small brains constrain insects to have limited behavioural flexibility and only simple learning abilities," said

"BUMBLEBEES, ALONG WITH MANY OTHER ANIMALS, MAY HAVE THE COGNITIVE CAPABILITIES TO SOLVE COMPLEX TASKS"

researcher Prof Lars Chittka.

Further tests showed that the bees were able to apply their 'training' to various situations, such as balls placed in different locations and balls coloured differently.

"It may be that bumblebees, along with many other animals, have the cognitive capabilities to solve such complex tasks, but will only do so if environmental pressures are applied to necessitate such behaviours," said researcher Dr Olli Loukola.



The bees' team colours are yellow and black

PHOTOS ©AHU/UNIVERSITY OF DUNDÉE; ©J. L. L. L. L. L.

ANTHROPOLOGY

FACE OF BRUTALLY MURDERED PICTISH MAN RECONSTRUCTED

This handsome chap may look like an East London hipster who knows his espresso ristretto from his latte macchiato, but he was actually a Pictish man who lived in the Scottish Highlands 1,400 years ago.

This mug shot was digitally reconstructed from a skeleton found buried in a cave in Ilkley Isle, Ross-shire by researchers from the University of Dundee.

The body was arranged in a cross-legged position with large stones placed on its legs and arms. Several severe fractures in the man's skull suggest he was brutally murdered before being laid to rest.

"This is a fascinating skeleton in a remarkable state of preservation which has been expertly recovered. From studying his remains we learned a little about his short life but much more about his violent death," said researcher Sue Black. "As you can see from the facial reconstruction he was a striking young man, but he met a very brutal end, suffering a minimum of five severe injuries to his head."

Radiocarbon dating indicates that the man died sometime between 430 and 630 AD. The remains were surrounded by evidence of iron smithing from around the same period and suggestions of more recent leather working.

Ongoing analysis of the skeleton and artefacts from the cave is expected to offer additional details of the man's place of origin and significance, as well as provide more information about the cave's archaeological and historical importance.



Even though the man was brutally killed, his body was laid to rest with some consideration





Artificial muscles made of smart fabric could be sewn into clothes to help disabled people get about more easily

MEDICINE

'KNITTED' MUSCLES COULD HELP THE DISABLED WALK AGAIN

Your woolly jumper may soon do more than keep you warm: Swedish researchers have created 'textile muscles' that could potentially be stitched into the clothes of injured or disabled people to enable them to move more easily.

"Enormous and impressive advances have been made in the development of exoskeletons, which now enable people with disabilities to walk again. But the existing technology looks like rigid robotic suits," said researcher Edwin Jager. "It is our dream to create exoskeletons that are similar to items of clothing, such as running tights that you can wear under your normal clothes. Such a device could make it easier for older persons and those with impaired mobility to walk."

The material is made by coating regular fabric with a fluid capable of conducting electricity.

IT IS OUR
DREAM TO
CREATE
EXOSKELETONS
THAT ARE
SIMILAR TO
ITEMS OF
CLOTHING

When a low voltage is applied to the fabric, the fibres from which it is made increase in length. By carefully controlling the knitted structure of the fabric, the researchers are able to create what they call "knitted muscles".

"If we weave the fabric, for example, we can design it to produce a high force. In this case, the extension of the fabric is the same as that of the individual threads," said researcher Nils-Krister Persson. "But what happens is that the force developed is much higher when the threads are connected in parallel in the weave. This is the same as in our muscles."

So far, the textile muscles have only been used in a simple robot device to lift a small weight. The next step is to integrate them into items of clothing, the researchers say.

PHOTO: TIGER BALANCIU/SHUTTERSTOCK; ARTWORK: BY CHRIS GARDIN, COURTESY SUEGLING MUSEUM, UNIVERSITY OF OTAGO. ILLUSTRATIONS: DANIEL BRONKHORST

PALAEONTOLOGY

GIANT PENGUINS MAY HAVE ROAMED THE EARTH ALONGSIDE DINOSAURS

Here's one penguin you definitely wouldn't want to p-p-pick up! Researchers have discovered a 61-million-year-old fossil belonging to a *Waimanu* – a giant penguin that stood 1.5m (4ft 11in) tall.

The fossil was unearthed near the Waipara River in New Zealand's Canterbury region, and dates back to the Palaeocene era. The bones differ significantly in structure from other *Waimanu* fossils discovered from the same period, indicating that there was a great deal of diversity amongst them. This could mean the evolution of penguins started much earlier than previously thought, perhaps even during the age of dinosaurs.

"This shows that penguins reached an enormous size quite early in their

evolutionary history, around 60 million years ago," said researcher Gerald Mayr. "What sets this fossil apart are the obvious differences compared to the previously known penguin remains from this period of geological history."

"The leg bones we examined show that during its lifetime, the newly described penguin was significantly larger than its previously described relatives," Mayr continued. "Moreover, it belongs to a species that is more closely related to penguins from later time periods."

The animal also likely differed from its more primitive relatives in another key way: it moved with the upright, waddling gait characteristic of modern penguins.

Prehistoric penguins were much larger than the birds we know and love today



POETRY LOVERS

Knowing your rhyming couplets from your iambic pentameter is good for you. Listening to the specific rhythms of poetry can trigger positive feelings in listeners' brains, researchers at Bangor University have found.

BIRDWATCHERS

It's time to dust off the binoculars. Indulging in a relaxing spot of birdwatching can make us less anxious and depressed, researchers at the University of Exeter have found.

GOOD MONTH

BAD MONTH

INTERNET TROLLS

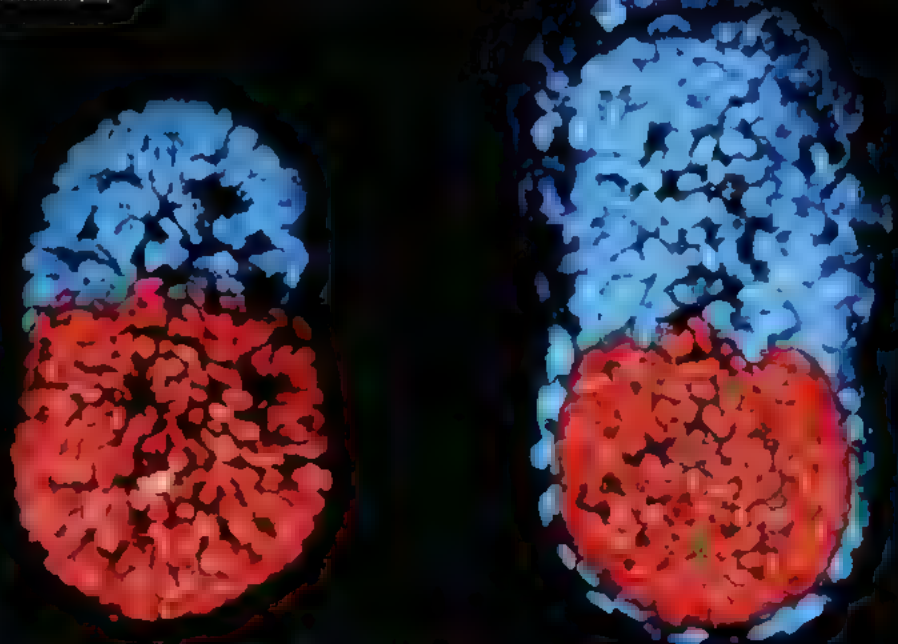
Like posting nasty comments online? It might be time to get back under your bridge: Google has started trialling a comment-policing AI to sift through internet forums and remove toxic posts.

TATTOO ARTISTS

Getting inked up can be just as painful for the artist as the client. A team at Ohio State University has found that the long working hours and poor posture that are typical for tattoo artists can lead to headaches and chronic back pain.



The mouse embryo at different stages of development, with embryonic stem cells (red) and trophoblast stem cells (blue).



MOUSE EMBRYO CREATED FROM STEM CELLS FOR THE FIRST TIME

By using two different types of stem cell, researchers at the University of Cambridge have successfully built an artificial mouse embryo in the laboratory – a breakthrough that may help us understand why two out of three human pregnancies fail during the early stages.

Our knowledge of early embryo development is still quite hazy, partly because of the strict rules around research involving real-life human embryos. The technique pioneered in Cambridge involves bringing together two types of stem cell: the embryonic stem cells (ESCs) that will go on to form the mouse's body, and the trophoblast stem cells (TSCs) that will go on to form the placenta.

The scientists placed both types of cell onto a 'scaffold' called an extracellular matrix, and observed how they then organised themselves just

as they would in a real-life embryo, with ESCs at one end and TSCs at the other. Because the third type of stem cell involved in the natural process – the endoderm stem cells that form the 'yolk sac' – was not present, the resulting embryos are not able to develop into actual mice.

Previous attempts to create embryos in the lab using only ESCs all failed, but it's hoped this breakthrough will lead to the creation of new avenues for embryo research.

"We are very optimistic that this will allow us to study key events of this critical stage of human development without actually having to work on embryos," said researcher Prof Magdalena Zernicka-Goetz. "Knowing how development normally occurs will allow us to understand why it so often goes wrong."

ANTHROPOLOGY

ROYAL MAYAN PENDANT POSES ANTHROPOLOGICAL PUZZLE

This sibling fit for a king. A piece of carved jade pectoral, discovered by archaeologists in what is now central Belize, has raised new questions about the Mayan civilisation that ruled Central America from around 2000 BC until the Spanish colonisation.

The pendant was unearthed at Nim Le Puunt, some 40km north of the town of Punta Gorda, in 2015. Nim Le Puunt, which was discovered in 1976, is known to have been a Mayan settlement between 150 and 850 AD. In keeping with the pendant's estimated creation date of around 600 AD,

However, it was believed to be a village of relatively low importance, lying on the outskirts of the Mayan empire. And yet the T-shaped pendant clearly belonged to a

member of the royal family, not only is it exquisitely crafted from a precious stone, but there are raised hieroglyphs on the back which say as much. The small jade pendant was made for King Jaanab' Q'uk' K'at'ab, who ascended to the throne in 647 AD, whose inscriptions on the walls of the 9th-Century tomb in which it was found show the king wearing the pendant in incense-scattering ceremonies.

So what were the king and his pendant doing in lowly-coexisting Nim Le Puunt, and why was the pendant buried in a tomb at all? It's as though an ancient British crown had mysteriously surfaced in a small fishing village in Devon, and archaeologists now must travel yet further.



IN NUMBERS

3
million

The number of people in the UK who suffer from colds and flu every winter thanks to vitamin D deficiency, according to a study by a team at Queen Mary University of London.

2
HOURS

The average time a wild African elephant spends sleeping per day – the least amount of any mammal studied to date.

12

The number of antibiotic-resistant superbugs named by the World Health Organization as posing a threat to human health.



FOSSILS

WORLD'S OLDEST FOSSIL HINTS AT ORIGIN OF LIFE ON MARS

This rock could host the remains of one of the oldest life forms on Earth. A team from University College London has discovered fossils of iron-oxidising bacteria that are at least 3.7 billion years old encased in layers of quartz in Nuvvuagittuq Supracrustal Belt (NSB) Québec, Canada.

The NSB contains some of the Earth's oldest sedimentary rocks that probably formed part of an iron-rich deep-sea hydrothermal vent system that provided a habitat for the planet's first life forms.

"Our discovery supports the idea that life emerged from hot, seafloor vents shortly after planet Earth formed," said researcher Matthew Dodd. According to Dodd, this rock is a perfect fit with other evidence of recently discovered 3.7-billion-year-old

sedimentary mounds that were shaped by iron-oxidising bacteria.

The fossils are similar to the iron-oxidising bacteria that are found near hydrothermal vents today. They were discovered alongside other minerals which are found in biological matter and are frequently associated with fossils.

The discovery could point back to a time when there was a hot, wet world present on Mars, suggesting that the Red Planet may have hosted life too.

"These discoveries demonstrate life developed on Earth as a special exception when Mars and Earth had liquid water at their surfaces, posing exciting questions for extraterrestrial life," said Dodd. "Therefore, we expect to find evidence for past life on Mars from hydrothermal seepage or if not Earth may have been a special exception."

MAIN IMAGE: This rocky outcrop where the fossils were found may once have been part of a system of hydrothermal vents.

INSET IMAGE: The tiny fossils contain tubules formed by ancient bacteria.

PHOTO: GEMMA MALLACE/INSET: MICHAEL J. WATSON/UCAL

SPACE

MOST DETAILED MAP OF DARK MATTER CREATED

It's dark matter as we've never seen it before. A team from Yale University has put together one of the highest-resolution maps of the elusive particles by using images from the Hubble Space Telescope to study three clusters of galaxies.

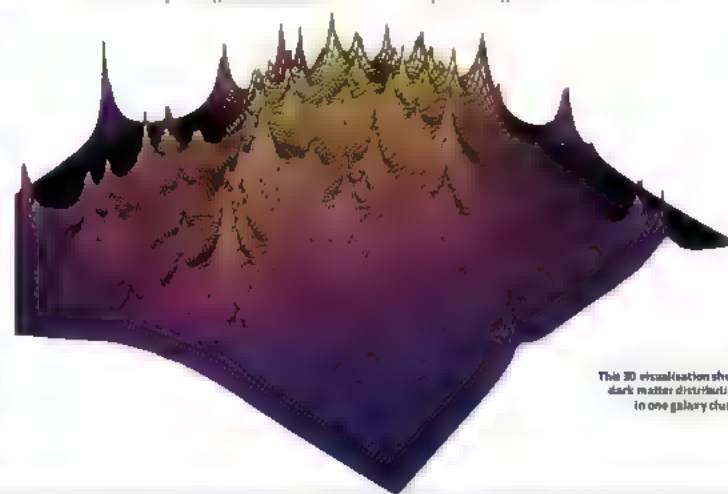
Dark matter is a theorised substance that doesn't reflect or absorb light and is thought to comprise 80 per cent of the matter in the Universe. It can only be detected indirectly through its gravitational effects.

Dark matter particles are thought to provide the unseen mass that is responsible for a phenomenon known as gravitational lensing, by bending light originating from distant galaxies. This light bending produces distortions in the shapes of galaxies viewed

through the lens. The team decoded these distortions to create the map of dark matter.

"With the data of these three lensing clusters we have successfully mapped the granularity of dark matter within the clusters in exquisite detail," said researcher Prof Prithvindra Natarajan. "We have mapped all of the clumps of dark matter that the data permit us to detect, and have produced the most detailed topological map of the dark matter landscape to date."

They found that the map closely matches computer simulations of dark matter theoretically predicted by the cold dark matter model – dark matter that moves slowly compared to the speed of light.



This 3D visualisation shows dark matter distributions in one galaxy cluster

THEY DID WHAT?!



'SURROGATE' HENS BRED TO LAY OTHER CHICKENS' EGGS

What did they do?

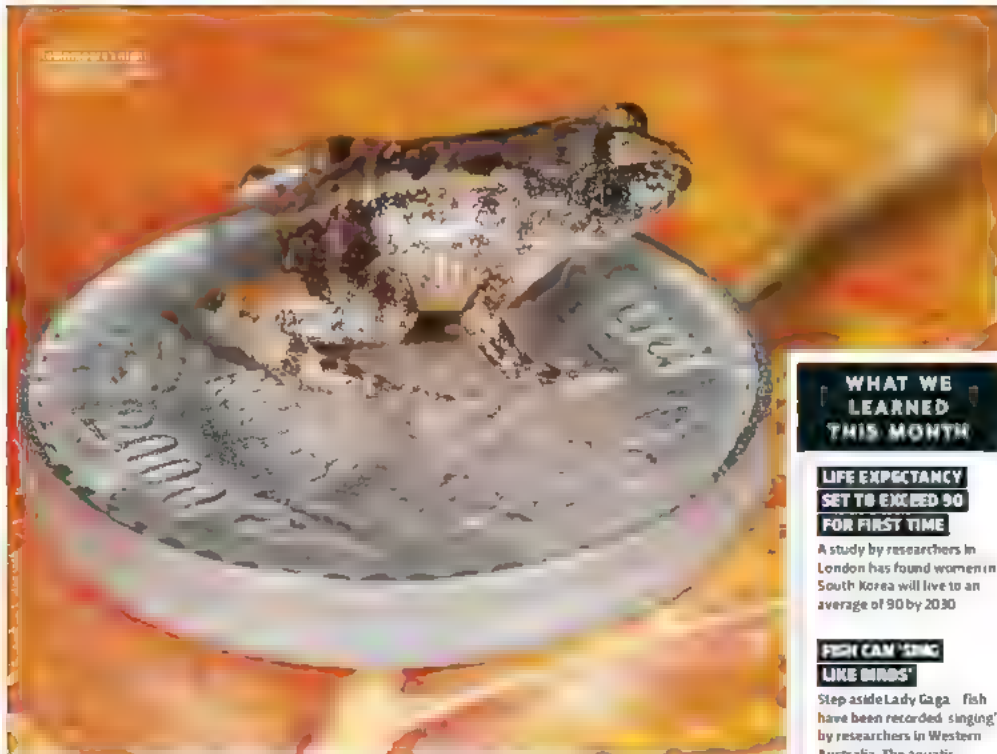
A team at Edinburgh's Roslin Institute used gene-editing tools to knock out the *DDX4* part of hens' genomes to create hens that are unable to produce their own eggs but are able to lay eggs for

Why did they do that?

To help the researchers want to create hens with primordial germ cells that lead to the production of eggs from other breeds of chicken. This is to produce eggs of the same breed.

What do they want to do that for?

In the short term, the researchers hope that the technique can be used to protect a breed of chicken, but it could also be used to speed up the rate at which new breeds of chicken are bred to help in conservation efforts.



ZOOLOGY

TINY NEW FROG SPECIES FOUND IN INDIA

This little guy belongs to one of seven new frog species that were recently found hopping among the fallen leaves in the forests of India's Western Ghats national park by researchers at the University of Delhi.

Part of the genus *Nyx ibatrachus*, more commonly known as night frogs, four out of the seven new species discovered are less than 15mm in length – small enough to perch on a human thumbnail.

Deep to being new to science, the frogs are relatively common in their local areas. "In the Western Ghats species are fairly abundant and fairly common. They have probably been overlooked because of their

extremely small size," says Dr. Sanku Chakrabarti, a research fellow who worked on the project.

The frogs were classed as "endemic" species and are part of an ancient genus of frogs that diversified into their current forms

approximately 70-80 million years ago. However, due to their close proximity to humans, several species are facing extinction.

"Over 32 per cent, that is one-third of the Western Ghats' frogs are already threatened with extinction. Out of the seven new species, five are facing considerable anthropogenic threats and require immediate conservation prioritisation," said lead researcher SD Biju.

WHAT WE LEARNED THIS MONTH

LIFE EXPECTANCY SET TO EXCEED 90 FOR FIRST TIME

A study by researchers in London has found women in South Korea will live to an average of 90 by 2030.

FISH CAN 'SING' LIKE BIRDS

Step aside Lady Gaga: fish have been recorded 'singing' by researchers in Western Australia. The aquatic symphonies occur at dawn and dusk, much like the choruses sung by birds.

BUTTERCUPS' GLOW IS CAUSED BY THEIR PETAL STRUCTURE

Ever held a buttercup under your chin to see if you like butter? The signature glowing effect is caused by an incredibly thin outer layer acting like an optical film and reflecting light. Dutch researchers have found

FIVE A DAY MAY NOT BE ENOUGH

A team at Imperial College London estimates that nearly eight million early deaths could be prevented worldwide if we all ate 10 portions of fruit and veg a day. Pass the carrot sticks.

PHOTO: J. BILLY



WHAT CAN WE LEARN FROM 'HIDDEN FIGURES'?

Gender and racial equality still have a long way to go

"THE WOMEN THEMSELVES WERE ALWAYS VERY MODEST ABOUT THEIR EFFORTS"

Having been a kid during the Space Race of the 1960s, I've always reckoned myself something of a space buff. While still in short trousers I could reel off the names of all the astronauts and cosmonauts and their spacecrafts. But I must confess the story behind the hit movie *Hidden Figures* came as a complete surprise.

Was it really possible that NASA had used rooms full of people to work out rocket trajectories and orbits by hand? And not just any people, but teams of mathematically gifted African-American women – at a time when discrimination on the basis of ethnicity and gender were rampant?

The story of how Katherine Johnson and her fellow "colored computers" – as they were known at NASA in the early 1960s – helped America win the Space Race is truly inspiring in both human and scientific terms. Each day Johnson and her colleagues tackled mathematical problems of mind-bending complexity while simultaneously dealing with routine sexism and racism.

Yet despite all of the hardships they faced, the quality of their work was such that when John Glenn, the first American in orbit, was given his flight details worked out using an IBM computer, he insisted on having them personally recalculated by Johnson – just to be sure.

So how come the story of Johnson and her colleagues has remained hidden for so long? According to author Margot Lee Shetterly, author of the eponymous book on which the movie is based, part of the reason is that much of their work was secret.

The booster rockets that were used to put the first US astronauts into space were essentially just modified ballistic missiles, which had originally been designed to lob thermonuclear weapons at the Soviets. As such, their range, accuracy and other characteristics needed to make trajectory calculations were classified. But as Shetterly researched her book, she found other reasons for the role of NASA's human computers remaining hidden – reasons that are hard to fathom today.

The mere fact that they were female meant their work was largely viewed as just a higher form of 'chore': women were supposedly naturally good at. Then there was the effect of the racial segregation in US military and federal institutions of that era, which even dictated who Johnson and her colleagues were allowed to sit next to in the work canteen. With so few heard their own circle to talk to, it's hardly surprising their heroic efforts remained unsung.

Perhaps most telling of all, however, is the fact that the women themselves were always very modest about their efforts. As Shetterly told *BBF History* magazine in a recent interview, when Johnson and her former colleagues learned their stories would be told in a book and a movie, their reactions were: "What's the big deal?"

Yet at the same time, they knew they had never got the accolades they deserved. This will seem utterly paradoxical – especially to those of us known as 'men'. From the first time we successfully use a potty, we males tend to be very keen on making sure everyone knows of our achievements. But women – not so much.

And no, it's not just me saying that. Research shows that women are less likely than men to put themselves forward for promotion, often because they think that if they just keep doing great work, someone will surely notice eventually. That's a big mistake – and one that benefits pushy blokes with no qualms about bragging to the boss.

In *Lean In*, her celebrated study of leadership, Facebook's chief operating officer Sheryl Sandberg cites this phenomenon as a key reason why women are under-represented at the top of their professions. *Hidden Figures* does a grand job of showing the foreshadowing and determination of Johnson and her colleagues in helping America win the Space Race. But anyone who thinks women would find it all less of a struggle today is living on another planet. **G**

Robert Matthews is visiting professor in science at Aston University, Birmingham

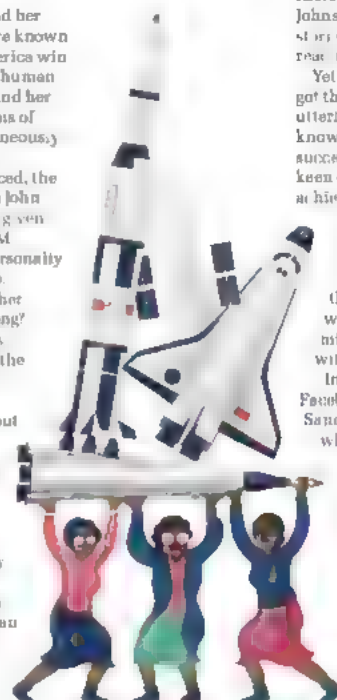


ILLUSTRATION: GARY BAKER

Supported by

SIEMENS

INTERNATIONAL
IMAGES
FOR SCIENCE
2017

THE RPS
ROYAL
PHOTOGRAPHIC
SOCIETY

OPEN FOR
ENTRIES!

CLOSING DATE
30 APRIL 2017

CALLING ALL PHOTOGRAPHERS, SCIENTISTS, ENGINEERS,
RESEARCHERS, COLLEGE AND SCHOOL STUDENTS!

This is an opportunity for you to submit your best pictures of science and its place in the world around us. Anyone can enter, whether using professional equipment or a smartphone. Entry is free and there are prizes awarded in each of the three age categories.

| | |
|---------------------------------------|----------------------------------------------------|
| GOLD AWARD (Age 26 and Over) | £1000 + RPS Gold Medal |
| SILVER AWARD (Age 26 and Over) | £500 + RPS Silver Medal |
| BRONZE AWARD (Age 26 and Over) | £250 + RPS Bronze Medal |
| GOLD AWARD (Age 18-25) | £750 + RPS Gold Medal |
| GOLD AWARD (Age 17 and Under) | £500 toward photography equipment + RPS Gold Medal |

For more information and to enter go to rps-science.org

The competition is proud to be a part of the Curiosity Project by Siemens, aiming to inspire the next generation of engineers. For more information visit siemens.co.uk/curiosity-project

IMAGE: PAINT DANCING TO MUSIC

© Richard Beech

From International Images for Science Exhibition 2016

Media Partner

EXTRA FOCUS

INNOVATIONS

PREPARE YOURSELF FOR TOMORROW



TOP OF THE RANGE

Meet the Range Rover Velar. Unveiled at the London Design Museum this month, its parent company Land Rover says this car's aesthetic is an exercise in reductionism – every stray line has been tamed. This is most evident inside, where Land Rover's designers have done away with the clutter of the dashboard. The in-car hardware – a pair of high-definition screens – has been built by Panasonic. It offers a full touchscreen experience, and you can flick content

and controls between the screens in the car. Land Rover has kept haptic 'magic rings' inside to make it less distracting to control while you're on the move. We're also happy to see a new leather interior made out of a new polyester/wool mix that the company says is as durable and easy to clean as its cow-based counterpart. And their most frugal engine will offer an impressive 53.5mpg, apparently. But we'll reserve our judgment until we test one later in the year.

WANTED!



GOODBYE, CRAMPS

LIVIA

Billed as "an off-switch for menstrual pain," Livia consists of the Livia device itself and two electrodes that you fix to your lower abdomen with gel stickers. Livia then directs a small electromagnetic current to the electrodes and sends pulses through the nerves, which its makers claim will block the signals that cause pain without the use of drugs. There's certainly a demand for it: Livia exceeded its Indiegogo funding target nearly 14 times over. It's CE approved and currently awaiting FDA approval in the US. \$149 (£120 approx), mylivia.com



POOCH PRYER

JAGGER & LEWIS SMART DOG COLLAR

Like a Fitbit for Fido, this smart device from Jagger & Lewis will track your dog's behaviour and provide analytics via an accompanying app. It clips onto your dog's collar, then tracks their body temperature, how far they're walking



how much they're eating and drinking and how often they bark. This information is then correlated against your dog's age and breed to alert you if something looks like it may be amiss. £149, jagger-lewis.com

VR ON THE MOVE

LENOVO THINKPAD P71



The flagship in Lenovo's new laptop range is this 17-inch model that's designed not just to handle virtual reality content, but to create it too.

Generating VR content requires lots of processing grunt and disk space, so you'll find four drive slots for HD/SSD storage, support for up to 64GB of RAM, Thunderbolt 3 ports

for connecting high-end peripherals and an optional 4K display, while its Xeon E3 processor is backed up by a 16GB Quadro P5000 graphics card. It is, in short, a beast—though if the price tag's beyond you, Lenovo has also just released the Yoga A12, a hybrid Android tablet for a mere £240 (\$1849 (£1485 approx), lenovo.com)

A CLASSIC REBORN

NOKIA 3310

Nokia has just relaunched the 3310, its hard-wearing candybar phone of the early noughties. Er, sort of. The new 3310 has a colour screen, 2MP camera, FM radio, GPS, SD card slot and 2.4G



Internet slot. It's not really the same phone, it just looks a bit like the old one. Its battery can manage 22 hours talk time and can run in standby mode for up to 31 days on a single charge, while that low price tag makes it ideal for using when you're out and about. £41, nokia.com

A CLEARER PICTURE

LOGITECH BRIO

Whether you're an avid vlogger or a serial Skype-er, there are plenty of reasons to ditch the basic webcam built into your laptop for something higher-specced. And they don't come any higher-specced than Logitech's new 4K offering, which is the first commercial consumer webcam to offer ultra-high-definition video with high-dynamic resolution. Note, though, you'll need a Windows PC with a Kaby Lake processor to get the full benefit. £199, logitech.com



APP FEED



Blynk

Add smart phone control to your Arduino or Raspberry Pi. Just drag and drop widgets to build your device's own interface. Free, iOS/Android



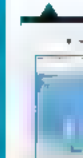
Lego Life

Take a Lego minifigure somewhere to make something new. Upload and share pictures of your minifigures. Free, iOS/Android



Sickweather

This is one for serious gamers. It's a weather app for your smartphone. Free, iOS/Android



Free, iOS/Android

IT'S ALL IN THE WRIST

GAMEBAND

Smart notifications and weather alerts are all very well, but wouldn't you rather be playing Pong? The makers of Gameband are certainly hoping so. It's a smartwatch with a 1.2GHz Snapdragon processor and a 1.63-inch AMOLED display that comes preloaded with 20 games. The Gameband itself runs on Android but is compatible with both Android and iOS devices. \$199 (£160 approx), gameband.com





THE BLACKBERRY IS BACK

This year, nostalgia dominated Mobile World Congress – the largest mobile technology conference in the world. Companies vied for the public's attention with the likes of 5G networks, autonomous driving, artificial intelligence, and smart wearables – but the undeniable stars of the show were two rehabilitated gadgets from the past: the Nokia 3310 (turn to p29) and the BlackBerry KEYone.

You'd be forgiven for thinking that BlackBerry had been consigned to the big tech rubbish heap in the sky, along with the likes of Palm Pilot and Google Glass. But the BlackBerry brand was recently bought by Chinese company TCL, which wants to resurrect the device for the surprising number of people who still pine after diminutive physical keyboards on their smartphones.

The device isn't on sale yet, so we can offer full judgment, but we can say that it looks like the phone's aimed at business users that made BlackBerry so

popular in the first place. The qwerty keyboard doubles as a giant trackball, letting you browse the web with one hand gesture. Meanwhile, its keys can be programmed to launch apps and there's a fingerprint sensor. It's a little scarier. Since security is important for a work phone, the KEYone comes loaded with software called DTEK, which is supposed to constantly monitor for security threats – BlackBerry claims it'll be the most secure Android device in the world.

Yep, that's right: the phone runs on Android. This is in contrast to most recent BlackBerry devices, which were bereft of apps due to its own-brand operating system. The phone's hardware is on par with most current Android phones and it looks to have great camera footage on Google's Pixel phone. Out at the end of April, the KEYone probably won't have us giving up our iPhones or Google Pixels any time soon, but it will appeal to the company's cult across Europe.

NEWS BYTES

DELIVERY BOTS ARE GO

The state of Virginia, US, has just legalised delivery robots, as long as the tiny trucks don't weigh more than 23kg, or travel faster than 16km/h. They expect shops to offer them within 3-6cm.



SLEEP EASY

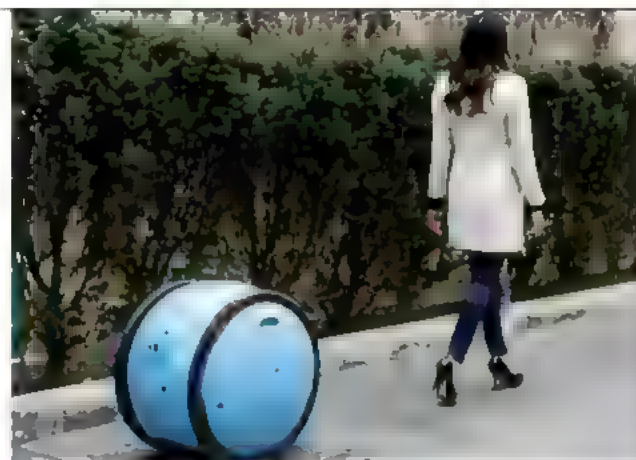
Sleep trackers could actually harm, not help, your sleep quality. 'Orthosomnia', aspiring to a perfect night's sleep, could become an unhealthy preoccupation, according to a report in the journal Sleep Medicine.

THIS PHONE WILL SELF-DESTRUCT

A device that crushes crucial chips in your phone has been developed by researchers at the King Abdullah University of Science and Technology. The mechanism could be applied to most modern devices and can be triggered remotely as a last resort.

OCULUS RIFT PRICE DROP

The pioneering VR headset just got \$200 cheaper (£162) after slow initial sales. The Oculus Rift S is now available for \$399.99, well ahead of its six-month target.



ROBOTS

Cute robot porter

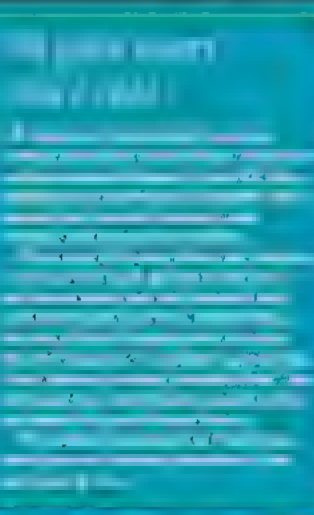
Gita is a prototype robot from Piaggio Fast Forward, part of the same group that makes Vespa scooters – that acts as your own personal porter. It stands 36cm tall, and is built to carry up to 18kg of supplies (that's a bit of crisp) inside its container.

The robot can operate in one of two modes. In autonomous mode, it

navigates using GPS and onboard cameras, alternatively you can strap on a camera-equipped belt and your trusty friend will follow you.

Sadly there's no word yet as to when or even if the Gita prototype seen here will go into full-scale production. But should make Saturday's supermarket trip a heck of a lot sweeter.

VIRTUAL REALITY



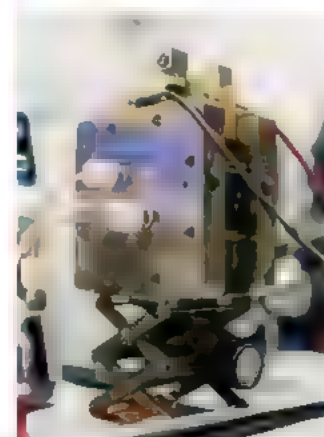
MATERIALS

Building better batteries

Two different batteries developed at Harvard and Pennsylvania State in the US could hold the key to better energy storage.

Both of the batteries aim to make energy storage more efficient, and less environmentally harmful. Much of the current research focuses on 'flow' cells – a type of battery that can be recharged by simply replacing the electrolyte fluids inside – and it's this path that the Harvard team has gone down. The researchers have modified the molecular structure of the electrolytes so that they can be dissolved in water and are more resistant to degradation. The result is a liquid battery that can store energy for over 10 years, and that contains no toxic materials. It's hoped the battery will find applications in storing energy from wind turbines and solar panels.

Meanwhile over at Penn State, researchers have been experimenting with a flow cell battery whose two electrolyte solutions consist simply of solutions of CO₂ and normal air. The difference in pH balance is then used to create an electrical current. The idea is that such a device could be fitted to coal- or oil-fired power stations and be used to reduce emissions while generating more energy.



MEDICAL MARVELS

These five gadgets could make GPs' lives easier in the near-future

1. BIO BATTERIES

Doctors increasingly use swallowable sensors to see what's going on inside a patient's body, but the problem is that to be safe, they can store only limited power and therefore typically last just an hour or two before the batteries die. But a team at MIT has unveiled a new battery that harnesses the electrolytes in digestive fluids to generate current. Using one such battery, the team powered a temperature sensor for over six days as it passed through a pig's digestive tract.



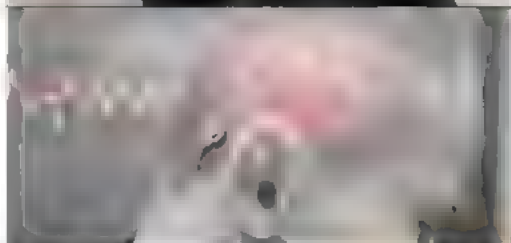
2. LITTLE LABS

A microchip has been developed at Stanford University that can carry out over 20 diagnostic tests, such as isolating and identifying breast cancer cells and screening for various toxins. Best of all, it can be manufactured for less than a penny per unit. It's hoped the device could be used to provide better healthcare in developing countries where hospitals are scarce.



3. TINNITUS APPS

Tinnitus, or ringing in the ears, is associated with the brain's auditory cortex. Researchers at the Weiss Center for Brain Research at the University of California, San Diego, have developed a brain implant that enables the user to 'quieten' the tinnitus by a small amount. The signals are transmitted from the implant to the person's phone. To stop the tinnitus, the user can then focus on altering the signal of a specialised app, changing the rate at which the process.



4. AUTOFOCUS FOR YOUR EYES

Reading glasses and varifocals could soon be a thing of the past. A team at the University of Utah has demonstrated a pair of prototype glasses featuring an autofocus system that adjusts the focal length of the glycerine lenses, depending on the distance of the object you're looking at. The refocusing takes just 14 milliseconds, but the prototype is still quite clunky – the next step will be to make the glasses smaller and lighter.



5. ROBOTS THAT CARE

As the population gets older and robots get smarter, their use in care homes may become widespread. That fact hasn't gone unnoticed by Segway Robotics or MIT, who recently joined forces to host a 'hackathon' in Singapore. Over the course of three days, 75 teams competed to find ways in which Singapore's Locomo robot could be modified for use in elderly care. The best ideas will be tested in Singapore, before hopefully being rolled out globally. Go-go gadget grand!



If you want to fit study into your busy life, The University of Nottingham's distance learning and part-time engineering and architecture courses might be for you

If you're looking for a more flexible mode of study, The University of Nottingham offers a range of courses designed to fit around your work, family and other commitments. It's the perfect way to gain the specialist skills and knowledge you need to further your career, retrain for another industry or

pursue your interest in research. Whether you choose a distance learning or part-time course, you'll learn from knowledgeable staff and experts in their field and have all the access you need to university facilities, including computer resources, libraries and laboratories.

For more information, including course details and entry requirements, please visit Nottingham.ac.uk/engineering/flexible-learning



Courses on offer

- Professional Practice in Architecture Part 3 (part-time)
- Applied Ergonomics and Human Factors MSc (distance learning)
- Sustainable Energy and Entrepreneurship MSc (part-time)
- Usability and Human Computing Interaction PGCert (distance learning)



@UoNEngineering
@NottinghamEngineering

The University of Nottingham



The University of Nottingham is a UK top 10 engineering faculty (QS World University Rankings 2015/16) and is ranked third for Research Power in Engineering (Research Excellence Framework 2014).

'Our engineers and architects are at the forefront of new research challenging conventional thinking, and producing novel and sustainable technologies that are changing infrastructure, communications, and the health of nations around the globe.'

Professor Andy Long
Pro-Vice-Chancellor, Faculty of Engineering



Where can we take you?

The University of Nottingham
University Park
Nottingham, NG7 2RD
0115 951 5559
www.nottingham.ac.uk

MUSEUM
OF LONDON
DOCKLANDS



Discover the fascinating finds unearthed
during construction of a railway under London

TUNNEL
THE ARCHAEOLOGY OF CROSSRAIL

10 February – 3 September 2017

Free entry

museumoflondon.org.uk/tunnel

020 7001 8544



REPLY

Your opinions on science, technology and our magazine

reply@sciencefocus.com

Science Focus, Tower House,
Fairfax Street, Bristol, BS1 3BN

@sciencefocus

www.facebook.com/sciencefocus

MESSAGE OF THE MONTH

Something to chew over...

My wife has been on a cat attack night at
my local pub. She's been to the pub
before, but this time it was a cat attack
night. She's been to the pub before, but
this time it was a cat attack night.

So, I was at the pub, and I was
expecting to see a cat attack night.
I was expecting to see a cat attack
night. I was expecting to see a cat
attack night. I was expecting to see a
cat attack night. I was expecting to see
a cat attack night. I was expecting to
see a cat attack night. I was expecting
to see a cat attack night. I was
expecting to see a cat attack night.

Paul Meior, St Albans

Microphones have their own unique triggers. For
some, it's a punchy sound, others a pyrotechnic
boom. The most common is the 'cat attack' sound,
which is a high-pitched, screeching noise.
This is caused by the cat's teeth hitting the
microphone's diaphragm. It's a common
trigger for many microphones, and it's
often used to start a recording. It's a
common trigger for many microphones,
and it's often used to start a recording.



Chomping and slurping noises fill some microphones with rage

Hawking hero

Our long-awaited feature on the life of
Stephen Hawking, our pop scientist,
has been a huge success. It was very popular
with our readers, and it was a great
success. It was a great success. It was
a great success. It was a great success.
It was a great success. It was a great
success. It was a great success. It was
a great success. It was a great success.

Stinky problem

The article about the stinky problem
(the stinky problem) was a great
success. It was a great success. It was
a great success. It was a great success.
It was a great success. It was a great
success. It was a great success. It was
a great success. It was a great success.

You're absolutely right and we apologise
for the error. Methane is a component of the
gas that is used to make plastic, but
natural methane is not used in the
plastic industry. The pungent smell
of plastic is caused by other gases in the
plastic, such as hydrogen sulphide, which is one of the smelliest
gases.

— Alan Neal, science writer

MORE FOR YOU

Don't forget that our magazine is also
available on all major digital platforms.
We have versions for Android, Kindle Fire
and Kindle e-reader, as well as an iOS app
for the iPad and iPhone.



Can't wait until next month to get
your fix of science and tech? The Science
Focus website is packed with news,
articles and Q&As to keep your brain
satisfied. sciencefocus.com



Special issue



THE ULTIMATE GUIDE TO SPACE EXPLORATION

The latest special edition explores the
spacecraft touring the Solar System, and
takes a peek at future space missions.

Performance without compromise

VORTEX ELITE

- Intel® Core™ i5-7500
- ASUS® H170M-R
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 1050
- 1TB Hard Drive
- Corsair 350W PSU
- Windows 10
- 3 Year Standard Warranty

£599*

VORTEX PRO

- Intel® Core™ i5-7500
- ASUS® Z170-P
- 8GB HyperX FURY RAM
- 2GB NVIDIA® GeForce® GTX 1050
- 240GB Kingston SSD
- 1TB Hard Drive
- Windows 10
- 3 Year Standard Warranty

FROM £999*

VORTEX ULTRA

- Intel® Core™ i7-7700K
- Maximus IX Hero
- 16GB HyperX FURY RAM
- 8GB EVGA NVIDIA® GeForce® GTX 1080
- 250GB Samsung 850 EVO SSD
- 2TB Hard Drive
- Windows 10
- 3 Years Warranty

£1,899*

LS-H02

- Overclocked Intel® Core™ i7-7700K
- Liquid Cooler® High RGB
- 32GB HyperX FURY RAM
- 16GB EVGA NVIDIA® GeForce® GTX 1080
- 250GB Samsung 850 EVO SSD
- 2TB Hard Drive
- Windows 10
- 3 Years Warranty

£3,549*

15.6" ULTRANOTE IV

- 7th Gen Intel® Core™ CPU
- Intel HD 620 Graphics
- Backlit Keyboard
- Full HD IPS Screen
- DDR4 Memory Support
- Wireless as Standard
- Windows 10
- 3 Year Standard Warranty

£529*

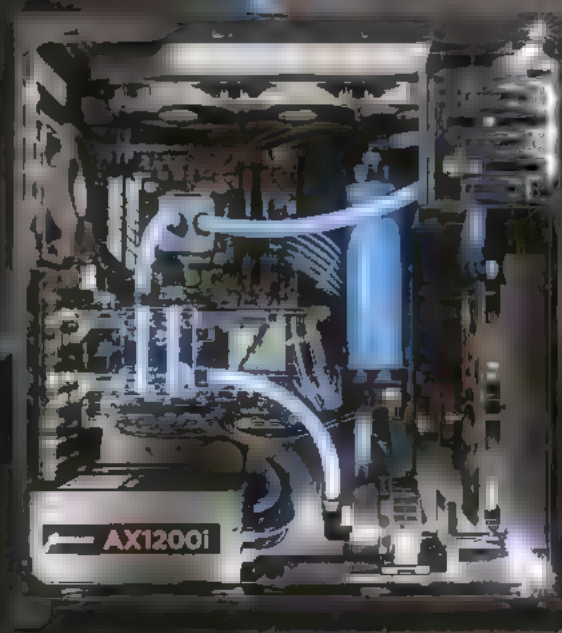
15.6" OCTANE III

- 7th Gen Intel® Core™ CPU
- NVIDIA® GeForce™ Pascal Graphics
- NVIDIA® G-SYNC™ Option
- Full HD IPS Screen
- Thunderbolt™ 3
- Wireless as standard
- Windows 10
- 3 Year Standard Warranty

£1,210*

Order your system now with PC Specialist

pcspecialist



UNLEASH THE
GAMER WITHIN
YOU...

Quality builds at a low price
Always

GET A FURTHER £15 OFF WITH THIS EXCLUSIVE VOUCHER CODE

BBF57

ORDER ONLINE NOW



SPECTRUM PRO

- Intel® Core™ i5-6400
- ASUS® Z170M-R
- 16GB HyperX FURY RAM
- 4GB NVIDIA® GeForce® GTX 1050Ti
- 120GB HyperX SAVAGE SSD
- 1TB Hard Drive
- Windows 10
- 4 Year Standard Warranty

FROM £699*

0333 011 7000

www.pcspecialist.co.uk



facebook.com/pcspecialist



@pcspecialist


© 2017 PC Specialist. All rights reserved. PC Specialist is a registered trademark of PC Specialist. All other trademarks are the property of their respective owners.

BACK TO THE MOON

WHY WE NEED TO GO

THE LAST
MOONWALKER,
GENE CERNAN,
DIED AGED 82 ON
16 JANUARY THIS
YEAR, SERVING
AS A STARK
REMINDER
THAT AN
AWFUL LOT OF
TIME HAS
PASSED SINCE
A HUMAN
LAST STOOD
ON THE MOON

WORDS Dr Stuart Clark

 On 14 December 1972, Gene Cernan stood at the foot of the lunar landing module and said, "...I take man's last step from the surface, back home for some time to come – but we believe not too long into the future". He was the 12th person to walk on the Moon, and clearly anticipated a fairly prompt return. That was not to be, as ambitions – if not funding – turned towards Mars. No one has walked on the Moon since.

Now the tide is turning. After years of interest in the Red Planet, the scientific and astronomical community is uniting behind a push to return to the Moon, both to continue the research that was started by the Apollo missions and to prepare for future exploration.

We spoke to five leading voices from the worlds of astronomy, philosophy, science and technology to understand why we have to go back.



PROF
LEWIS DARTNELL

Astrobiologist,
University of Leicester, UK

"The only astrobiological reason that you might want to go to the Moon is that it perhaps preserves ancient rocks from the Earth that have been splashed up by big asteroid strikes. And here I would want to tip my hat to Ian Crawford, University of London, for this idea."

The Earth is an active and dynamic place. That's important in the emergence of life and its long-term evolution over billions of years. Yet the planet's dynamism poses a problem when you are trying to find the earliest traces of life on Earth because most of the planet's crust has been destroyed by plate tectonics [the shifting and recycling of the Earth's surface rocks].

The Moon, on the other hand, is a stable, static and even boring place in the sense of active processes. If there were a way to get ancient rocks from Earth up onto the Moon, they would stick around for a long time, as they wouldn't be eroded or destroyed by plate tectonics. This is where asteroid strikes come in. If chips of the Earth got blown off our planet and up into space, the Moon would sweep up that material and preserve it.

So it stands to reason that there are probably ancient Earth rocks on the Moon that could contain microfossils or chemical fossils that would tell us about the origin of life on Earth. The problem is that it is going to be quite hard to find these flecks of Earth. You might start looking for hydrated minerals, which are abundant on Earth but very rare on the Moon.

Any material splashed up would be distributed randomly across the Moon but you could look for places where the material has been preserved.

The main problem of preserving bio-signatures in space is the cosmic radiation. These high energy particles travel at close to the speed of light and are destructive when they hit coils of organic molecules. So we might want to target ancient lava flows on the Moon that may have covered up any Earth rocks that were lying on the surface at the time and are now protecting them beneath several metres of rock.

There would be the issue of mapping to identify and date the lava flows, and then sending a mission to drill on a lava flow of the correct age.

It would be hard work. It would be like looking for a needle in a haystack without the use of a magnet. On the other hand, the pay off would be enormous. You would be finding Earth rock that is far older than anything found on our planet. So there is a lot to gain from doing this.

"THERE ARE
PROBABLY ANCIENT
EARTH ROCKS ON
THE MOON THAT
COULD CONTAIN
MICROFOSSILS OR
CHEMICAL FOSSILS"



NAVEEN
JAIN

Co-founder and chairman, Moon Express

If I were to paraphrase John F. Kennedy, 'We chose to go to the Moon not because it is easy but because it is great business'."

When Moon Express lands on the Moon, we will become the first private company to do so. But more importantly, we become the fourth superpower to do so. That is quite symbolic of things to come. To me, the next set of superpowers are likely to be entrepreneurs, not nation states.

The time is now right to use technology to solve the grand challenges facing humanity. I argue that landing on the Moon could potentially bring world peace. We fight over land, water and energy yet all we have to do is look up into space and here is an abundance of these things.

It is only a matter of time before we get hit by a massive asteroid. If we live only on Earth then humans are going to become extinct like the dinosaurs. Wouldn't you prefer to have some entrepreneur creating an underlying infrastructure so that we can really become a multi-planet society?

What we will be doing is creating the underlying infrastructure of space. We think of ourselves as the iPhone of space. Nine-and-a-half years ago, Steve Jobs launched the iPhone and the App Store. Obviously he had a seriously good idea of what people could do with the device but no one imagined that the number one thing that people would use their iPhone for was to throw birds at pigs [the Angry Birds game]. But that's exactly what people did and it took seven years until something else captured the imagination of humanity and that was Pokémon Go.

Now that we have routed this, for one of the Moon with Moon Express, we have to ask ourselves what is going to be the Pokémon Go. Will that be something that Moon Express will create, or is that something that we will allow other entrepreneurs to do? It could be bringing stuff down to Earth, or using stuff to create habitats on the Moon.

My gut reaction is bringing the lunar rocks to Earth could be the most beneficial task initially. We could disrupt the diamond industry. Diamonds were never the symbol of love and romance until the 1950s. De Beers created a brilliant campaign to sell that idea. If you are an entrepreneur against a monopoly you don't fight them, you change the game. So, we bring back the Moon rock and we change the paradigm. It's not enough to give her a diamond. If you love her enough you give her the Moon.

MISSIONS TO THE MOON TIMELINE

[NEAR SIDE OF MOON]



[FAR SIDE OF MOON]



MISSIONS STATS KEY

- SOVIET UNION
- UNITED STATES
- JAPAN
- EUROPE
- CHINA
- INDIA
- ✈ CRASHED MISSION
- 🚗 ROVER
- 🏠 LANDER
- 💥 CRASH LANDED

Spacecraft Launch date

Year

● LUNA 2 SEPT 12

1959

1960

1961

1962

1963

1964

1965

1966

1967

1968

1969

1970

1971

1972

1973

1974

1975

1976

1977

1978

1979

1980

1981

1982

1983

1984

1985

1986

1987

1988

1989

1990

1991

1992

1993

1994

1995

1996

1997

1998

1999

2000

2001

2002

2003

2004

2005

2006

2007

2008

2009

2010

2011

2012

2013

2014

2015

2016

2017

2018

2019

2020

2021

2022

2023

2024

2025

2026

2027

2028

2029

2030

2031

2032

2033

2034

2035

2036

2037

2038

2039

2040

2041

2042

2043

2044

2045

2046

2047

2048

2049

2050

2051

2052

2053

2054

2055

2056

2057

2058

2059

2060

2061

2062

2063

2064

2065

2066

2067

2068

2069

2070

2071

2072

2073

2074

2075

2076

2077

2078

2079

2080

2081

2082

2083

2084

2085

2086

2087

2088

2089

2090

2091

2092

2093

2094

2095

2096

2097

2098

2099

2100

2101

2102

2103

2104

2105

2106

2107

2108

2109

2110

2111

2112

2113

2114

2115

2116

2117

2118

2119

2120

2121

2122

2123

2124

2125

2126

2127

2128

2129

2130

2131

2132

2133

2134

2135

2136

2137

2138

2139

2140

2141

2142

2143

2144

2145

2146

2147

2148

2149

2150

2151

2152

2153

2154

2155

2156

2157

2158

2159

2160

2161

2162

2163

2164

2165

2166

2167

2168

2169

2170

2171

2172

2173

2174

2175

2176

2177

2178

2179

2180

2181

2182

2183

2184

2185

2186

2187

2188

2189

2190

2191

2192

2193

2194

2195

2196

2197

2198

2199

2200

2201

2202

2203

2204

2205

2206

2207

2208

2209

2210

2211

2212

2213

2214

2215

2216

2217

2218

2219

2220

2221

2222

2223

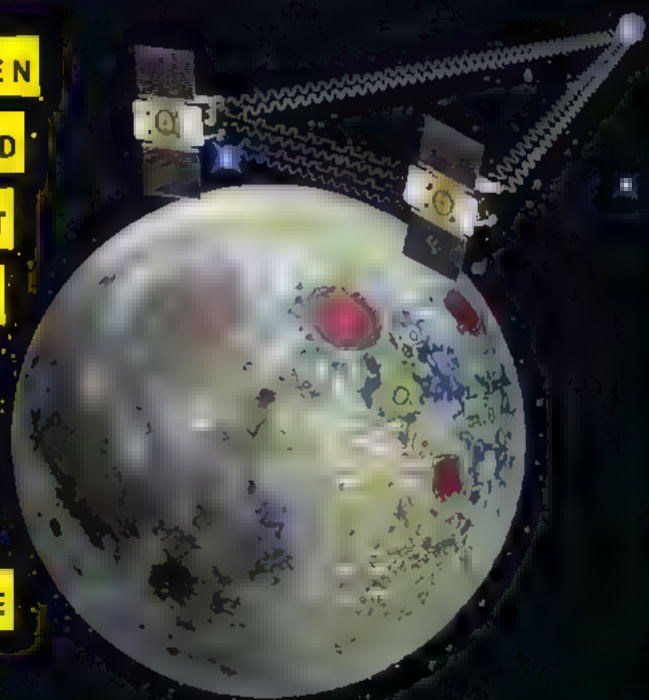
2224

2225

2226

2227

2228



Philosopher, Lawrence Technological University, Michigan

Philosophy has to do with understanding our relationship with the world. In that sense, it's inexorably a bound task. One. It seems to me that the other philosophical concern of this is what happens if we go to places like the Moon.

We can look at what has already happened. By going to the Moon with Apollo and the numerous war have come to a rest, it is better what the Earth has seen. So knowledge of the planetary system and of the cosmos is now knowledge of the Earth. It is not a certainty. It is something that a few years in the future will become. It makes us desperate to learn the universe and, once we understand the universe, and this is the point of philosophy, a knowledge we can then use to try to do what we better.

Few of us understand what the Earth is like as extremely important because the Earth has changed. To understand that we need to know what kind of planet the Earth was when it formed and what kind of forces have acted upon it. One of the most important objects that we have to study is the Moon. By going to the Moon only a few times, we accumulated an extraordinary amount of knowledge about what the Earth was like because the Earth and Moon apparently formed together.



Professor of planetary geosciences,
Queen university, UK

Lunar exploration has been going on for a very long time. In 2005, we have a successful mission to the Moon thanks to the GRAIL, gravity research from NASA. For these are part of a long history of the Moon and there are plans for a new lunar mission. Lunar Mission One is going to South Pole A-Heaven, a crater to the South Pole. A long exploration is being carried out by a lunar rover, going to the

You do need to get a new linoleum underlayment as well as a half-inch square tile spacers at the corners and for taking down the tiles. It's a major job to take from April to July, left four residentialers on the Moon for recording.

in earthquakes. They weren't brilliant but it's the only other proprietary index that we've got a methodology for. They focus on about the M-caps in energy but they were turned off after a few years - simply to save the day.

A few sacred pictures that a wise ruler would give us great insight into the Moslems' views. But you have to burn these pictures to keep them so that you can use them properly to the ground.

And there are heat flux experiments. We don't know what rate the Moon's internal heat is leaking out towards the surface. They tried to measure it on Apollo and it didn't work. They had trouble getting a good handle to the ground. So we are guessing at the lunar heat flow until we can get back, drill a hole and put some equipment down it. And we probably get to heat up the place to do something that finally

One big assignment to work on in March is a charge we have yet to overcome. The unit last runs and fires with day and night because of electrical static charges. You can get dust bunnies into your machinery, says that guy, vice problems.

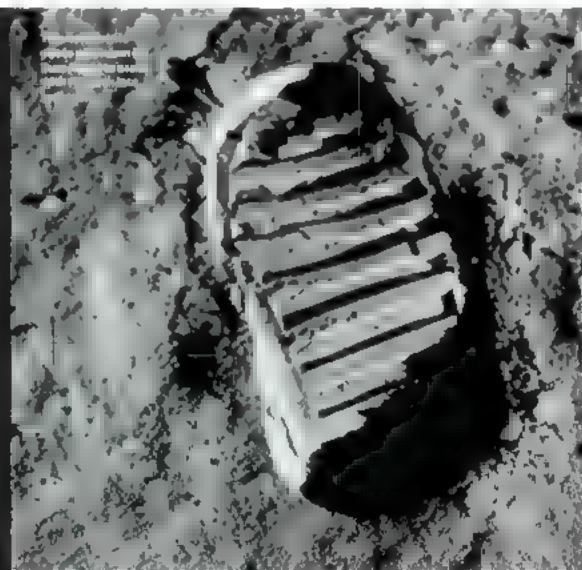
If you've got people there, you can overcome

ABOVE NASA's GRAIL mission flew two spacecraft around the Moon to analyse its gravitational field. But not all Moon rock movement can be taken from orbit

problems. They can deploy equipment and drill holes and they can wander around looking for geological observations. The range is so great that six were spotted by an astronaut from one of the last Apollo missions. They thought it was so interesting that they were brought back from an expedition to the moon. If a comet turned up there they would get a usual thing.

The Mars rovers—impressive though they have been—haven't gone as far as astronauts doing the Moon buggies to it. It's a lot more expensive when people are there, and you get a lot more done.

I was taken when April happened, and I thought it was the future. I thought that was what we were going to be doing people in space. It was inspiration for me. There is a bond of friendship between people, there because it inspires the next generation of scientists. I feel I think you can decouple that from the scientific facts that you're going to find on. As well as the histories that you are going to unravel your science going to be inspiring the next generation of scientists.



Even if this is not the case, it is still important to find out how the Earth and the Moon came to be together — or how not.

The Moai has a record of disasters with counts as late as 1850, showing by the size and number of raters in its surface that we do not have on the 10th. The Moai knows of such

To understand a faith is to understand the faith as a faith which makes it understood what practices are how they extend how the everyday ideal how it is related to the Sun and so on. The Mundanis is not the Soteriological but it is going to hold a perspective on understanding of our place in the Universe.

Exploring with friends is a far more expensive and dangerous than exploring by yourself. In the end, we have to find a way to save money as other people's would use to make a way to find a way to find a way.

Steve Seabrook, the person in charge of the Mark taxers, insisted that he was not pleased with everything at a road house in the previous six months — and he said that an astronaut could have done it all in a single day.

It's great that we have those machines but even so, we need to read there. I also think it is good to have early pictures as a reminder so that people can then dream about them and participate in them.

Going to the Moon the first time around was so exciting. Going back will give us the opportunity to go to other, more exciting places.



COMMANDER
CHRIS HADFIELD

Astronaut, first Canadian to walk in space

"Exploration is what you do as things
experience a crisis or a need for a
informed decisions. If we never explore then we
cannot improve and expand. Exploration is
fundamental to human nature. It's why we learn
to walk before we learn to talk because we have to
try, just to see how well we can do it. And we have to have experience as part of our
society in order to have well-informed society."

"A lot of the things in the world we do with
technology. Because you develop technology,
you living there has enormous variables
consequences for the future."

"There are so many precedents in history. I look
at the businessmen of England in 1496 who were
affirming and asking about Columbus. Well, okay,
but discover a new world, but then we do
anything as a quick look, we made? But
a few far-sighted people in the Bristol area
and a few in London said, 'I think exploration is
going in and to good things. It's going to take a
while to get any money back out of this. John
Columbus. And 1496 was a complete bust. Columbus
launched out of Bristol, in one ship, and didn't
know what he was doing, but he earned a bit."

"He came back and then in 1499, he was in
New France and then up to North America
England and then the great English exploration
over the next 300 years."

"The real question is at what point does our
technology advance enough that exploration
becomes economically viable. What parts are okay
to be done by sensors and how do we determine
what a robot should do? We can stick a weather
station in Antarctica and it will tell us the air
temperature and the wind speed. But that is not a
very piece of information that we need to know
about Antarctica. Most of the data needs to be
taken by people, and robots are terrible at
doing that."

"There is nothing magic about the space in
space exploration, but people have a very skewed
view of taking exploration into the third
dimension. But it's that rate to think, like this
as there are so many hidden risks that are
almost invisible. You could say, 'Oh, well, the
technology is too expensive.' Well, it was pretty
expensive to do each of those things at the
beginning, but it becomes a part of what we
do, and who we are as a species."

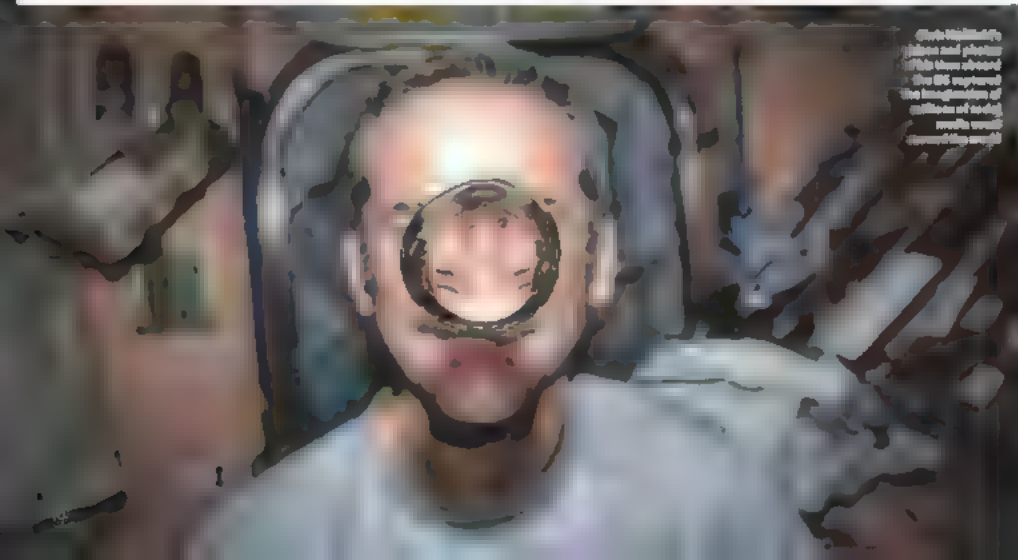
"So should we forsake lunar exploration for
Mars exploration? They're both largely
unknown. The real question is how do we not blow
it? How do we not make fatal mistakes. We're going
to get it wrong. On the [International] Space
Station, on my three space flights, what went wrong
at the time? You would have a hard time counting
the number of times that we needed to be saved by
bringing replacement equipment up from Earth."

"If we go to Mars for a six-month voyage, then we
are basically trapped in our own ignorance. We're
going to end up being like the Franklin
expedition, where you think you know what
you're doing, but you know everybody. We have to
recognize that failure is a big part of success
so we have to give ourselves the opportunity to fail
without destroying the entire effort that you are
trying to accomplish."

An Apollo 17
astronaut uses
moon buggy to
explore the lunar
surface



"EXPLORATION IS
FUNDAMENTAL TO
HUMAN NATURE.
IT IS WHY WE WALK
BEFORE WE TALK"



Chris Hadfield
takes and photos
of his own shadow
on the moon
surface. The
background of
the image is a
million of miles
away from
any other world.

**DON'T LET THIS
YEAR'S ISA
ALLOWANCE
GET AWAY.**

LET'S TALK HOW.

Secure it in
cash park
now, choose
funds later.



If you want to make the most of your £15,240 ISA allowance before the 5 April deadline, but don't have time to choose funds, turn to our ISA Cash Park.

It lets you hold some or all of this year's ISA allowance in cash, so you can decide which funds to invest in later.

When you're ready, our award winning guidance can help you make your choice. It offers helpful guides, online tools and fund recommendations, as well as regular market insights.

Secure your ISA allowance today.

Apply online at fidelity.co.uk or call us on 0800 368 1721.

Please remember that the value of investments can go down as well as up, so you may not get back the amount you invest.

The value of tax savings and eligibility to invest in an ISA depend on individual circumstances and all tax rules may change in the future. Fidelity's guidance service is not a personal recommendation.



FidelityTM
INTERNATIONAL



Do social networks make us **antisocial?**

MANY OF US HAVE EXPERIENCED THE WAYS IN WHICH SOCIAL MEDIA HAS CHANGED THE ONLINE WORLD. BUT SHOULD WE BE WORRIED ABOUT IT ALTERING OUR BEHAVIOUR TOO?

WORDS: DR DEAN BURNETT

Dean is a doctor of neuroscience at Cardiff University. His debut book, *The Idiot Brain*, is available now. You can follow him on Twitter @garwboy

R

ecently, I witnessed the unpleasant breakdown of a relationship. One partner accused the other of infidelity and promiscuity; the other retorted with claims of emotional abuse, drunken behaviour and an inability to perform sexually. All this, in much more swearsy language than that conveyed here. It got nasty fast, with children being dragged into it, and friends taking sides and furiously rowing with those who'd taken the other side. All very grim, and it made me vow to avoid any and all of those involved as a result.

That wasn't difficult though, as I'd never actually met any of them to begin with. This whole breakdown happened on Facebook. Some friends of friends had asked to add me to their network. I'd unthinkingly agreed, and thus I ended up with a front-row seat to their hideous break-up. Ironical that a social network was essentially responsible for the destruction of so many social bonds.

You've no doubt heard many complaints about social networks before. They're time-consuming, invasive, confusing, compromise your privacy and so on. But do they actually make us antisocial? Is there any credibility to that claim?

"The truth is, our social interactions, both online and in person, have a huge effect on our thinking and cognition"

If like many do, you draw a clear line between online interactions and real-world interactions, with more important being placed on the latter, then yes, arguably there is. But to really get to the heart of the matter, you have to look at how social networks affect our behaviour and attitudes towards other people. They can and do have significant impacts on these things, because of the way our brains work. The truth is, our social interactions, both online and in person, have a huge effect on our thinking and cognition. The social brain hypothesis, first put forward in

the 90s by anthropologist Robert Dunbar, suggests that our social nature is why we have such big brains to begin with. The argument is that primitive humans banded together in communities, and this cooperative approach proved very useful for our survival. But this lifestyle requires a lot of information to be processed: who do you trust? Who will help you? Who owes you favours? And so on. A substantial amount of data needs to be available at all moments in time. Basically, you need a lot of grey matter to maintain this. That's the theory, anyway (and there are others).

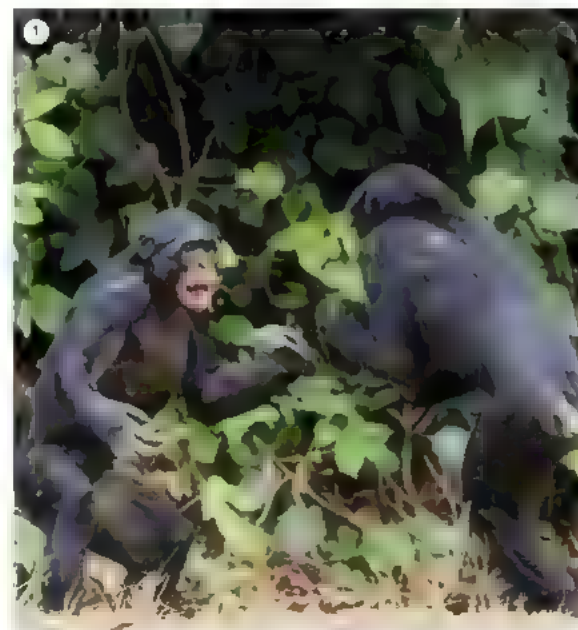
In support of this, brain imaging studies have shown a network of regions, including ventral medial structures and temporo-parietal junctions, which show increased activity when the subject contemplates being part of a group. Areas like the ventral medial prefrontal cortex and anterior cingulate cortex show increased activity when processing a sense of self, our identity and when processing awareness of the groups or communities we feel we're part of. This all suggests our social interactions are a major component of our identity at a very fundamental level.

SOCIAL BUTTERFLY

Humans need social interactions. Depriving humans of social contact, as when prisoners are sent to solitary confinement, is recognised by psychologists as a form of torture. On the other hand, too much social interaction is also good either. Social interaction is mentally taxing, but it's also a good workout for the brain, as it requires mental effort. This explains the apparent contradiction between humans needing social interaction, but also needing privacy. Sometimes, it's what our brains need: we need privacy, get away for a bit and 'recharge'.

All this shows that the brain strikes a precise balance between social and solitary interactions. But just as pulling 10 times the required amount of sugar into a cake doesn't make it 10 times better, so social networks can amplify aspects of socialising and social relationships in ways that are unhelpful, if not downright harmful.

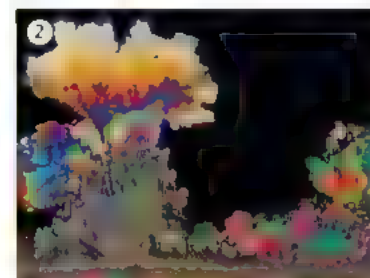
As early as 2010, professional psychiatrists were arguing that social network addiction was a real, ●



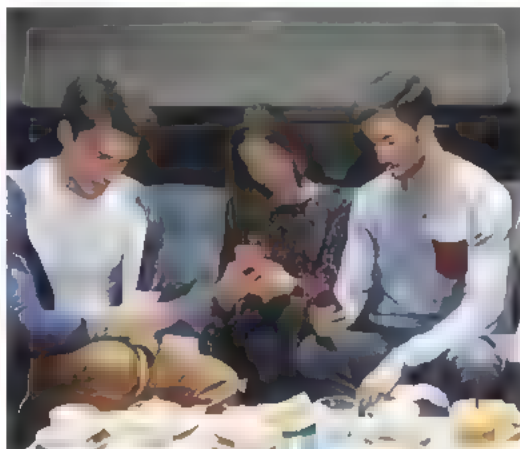
1 Compared with other animals, including our closest relatives, we are quite friendly

2 Dopamine is released by the brain when we enjoy a successful social interaction, giving us a rush of pleasure

3 We can control how we portray ourselves online by only posting the best updates, videos and images



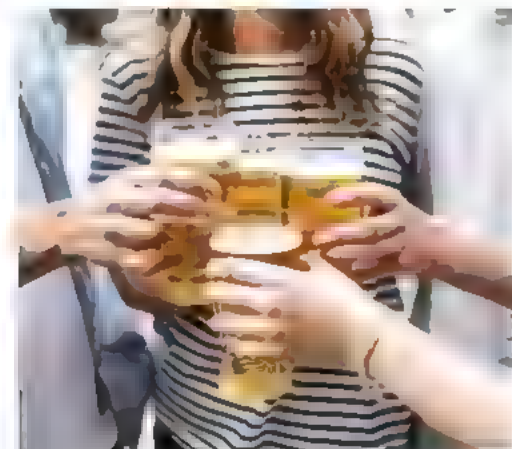
PICTURES: GETTY IMAGES / SHUTTERSTOCK



Social networking can trigger reward pathways in the brain, and may lead to addiction



We are social creatures – isolation is used as a form of torture and can warp the mind



Spending time socialising with people can be hard work for the brain

phenomenon that should be classed as a clinical disorder, citing a case study of an individual who spent five hours a day checking Facebook, rarely leaving the house to do so, losing jobs and missing out on other activities. The therapist consulted to check their updates – tantamount to opening a beer during an AA meeting. It essentially means cutting off all other forms of social contact to focus solely on social media, to the detriment of your overall existence.

There are explanations for this. A successful social interaction means we experience a real-world reward in the brain. Oxytocin release gives a general sense of well-being and connections and the mesolimbic reward pathway, buried deep in the centre of the brain, releases dopamine, giving a rush of pleasure. Some argue – and a few studies even provide some evidence – that a successful social interaction can be as rewarding as a drug high. Such as a popular Facebook post or widely shared tweet, can also produce this positive response in the brain.

Unfortunately, these social hits are a lot easier to get online without all the effort of real-world interactions. Drugs of abuse operate on similar principles, triggering the reward pathway but without the hassle of actually doing the action that the brain would consider deserving of a

reward. Over time, the brain adapts to expect these pleasurable signals, and does things like disrupt the areas responsible for inhibitions or conscious self-control to keep them coming. Indeed, a 2013 neuroimaging study at the University of Zurich led by psychologist Dr Katrin Preller revealed that cocaine addicts have diminished activity in areas like the orbitofrontal cortex, resulting in reduced emotional empathy and willingness to socialise. So if social network addiction is exploiting similar mechanisms to cocaine addiction, then social networks may well be having an ironically negative impact on individual's ability to socialise, rendering them more anti-social. More research is needed.

VIRTUAL REALITY

Another issue is that people have a greater level of control over their interactions in the virtual world, to a much greater degree than in the real world. You can put up only good photos, delete unwise comments, speech bubble, share smart memes and so on. This satisfies an underlying process the brain engages in known as impression management, where we're constantly compelled to present the best possible image of ourselves to others in order to make them more likely to approach us.

A 2014 study led by the University of Sheffield's Dr Tom Farrow looked at impression management. Using scanning technology, the team asked subjects to choose behaviours that would make people like them, and that would make people dislike them. Activation was recorded in regions including the medial prefrontal cortex, the midbrain and cerebellum, suggesting that these brain regions are involved in processing the image of ourselves we want to present to others.

However, these areas were only noticeably active when subjects tried to make themselves look bad – that is when they were choosing behaviours to make people dislike them. If they were choosing behaviours that made them look good, there was no detectable difference to normal brain activity. Coupled with the fact that subjects were much faster at processing behaviours that made them look good as opposed to bad, the conclusion was that presenting a positive image of ourselves to others is what the brain is doing all the time! It's the brain's default state.

Granted, it was a small and limited study, but it's an interesting outcome nonetheless. And if we're constantly focused on presenting a positive image of ourselves, it's no wonder social networks are so popular, as they offer a much greater sense of control of how we come across.

But this control is a double-edged sword. Even if you're just sitting with friends, the tendency to check your phone rather than talk can be overwhelming. The brain is usually averse to risk, preferring predictable options over less certain ones, and the calm interface on the screen is often subconsciously more reassuring than the chaotic conversation going on around you. The people you're with may consider this behaviour antisocial. And right you are.

More worryingly, a 2015 survey of men aged 18-40 by Jesse Fox and Margaret Rooney in the journal *Personality and Individual Differences* revealed that the amount of time spent on social networking sites, posting selfies and, revealingly, editing selfies to make them look better, was correlated with traits like narcissism and psychopathy. This isn't to say social networks cause these things, but they offer an outlet, a way for them to be expressed free of consequence,




where they may otherwise be criticised or challenged, thus ensuring more socially acceptable behaviours.

Another intriguing finding from a 2015 study led by Prof Iov Petuchella at Limerick University was that certain types of behaviour on social networks – namely extraversion and 'openness' – actually increase the odds of being a victim of cyberbullying. It may sound counterintuitive, but it makes a certain amount of sense. A person may typically keep their more flamboyant or expressive nature suppressed because social norms deter such things. Subtle signs of discomfort in those around you, awkward body language and responses, muted atmospheres – these all act to keep gregarious or overly personal tendencies in check, to some extent.

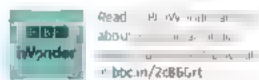
However, such cues aren't present online, so you can be as overly expressive or personal as you like on there. But other people may find this unsettling, or off-putting, or could see it as cynical attention-seeking. Either way, they react aggressively and attack the person. But social networks also protect the attacker from the consequences of their actions, introducing a distance and degree of anonymity between themselves and their victim, shielding them from the immediate effects, but supplying the same rush of having lowered someone's status and boosted their own. So social networks again become a way to facilitate and perpetuate antisocial actions.

Social networks also give us the ability to pick and choose what we see and hear from others, meaning we can end up in the oft-cited 'echo chamber'. Social networks make it much easier to form groups, and constantly remain part of them. This can give us a more 'extreme' leaning, making more intolerant of contrasting views as we grow unused to encountering them. What should be a casual meet-up in a pub can easily become a blistering row about a football team. Antisocial behaviour caused by social networks.

It's not all doom and gloom. More nervous or socially awkward people can be liberated by the control and organised communication offered by social networks, and great friendships and relationships can form across the world now that would never have been able to exist before. But the truth is, for all that they may sometimes not work that well, the human brain has evolved a variety of ways to make sure social interaction happens as efficiently as possible. Social networks, though, throw many spanners in the works here, causing overstimulation, which can sometimes mean they end up achieving the opposite of what they're built for, and making people antisocial.

Like and share this article if you agree!   

DISCOVER MORE



Read about...
bbc.in/2c8Grt

"As early as 2010, psychiatrists were arguing that social network addiction should be classed as a disorder"

FOP306

SUBSCRIPTION ORDER FORM

Please complete the order form and send to:
FREEPOST* IMMEDIATE MEDIA (please write in capitals)

UK DIRECT DEBIT

☐ Yes, I would like to subscribe to/renew **BBC Focus** and pay £ 6.20 every six issues (please complete form below)*

YOUR DETAILS (ESSENTIAL)**

Title Forename

Surname

Address

Postcode

Home phone no

Mobile phone no

Email

☐ I wish to purchase a gift subscription
(please supply gift recipient's name and address on a separate sheet)

Instructions to your bank or building society
to pay by Direct Debit



To: the Manager (bank/building society)

Address

Postcode

Name of account holder

Bank/building society account number

Branch sort code

Payment reference number (please use only)

Signature

Date

Signature's identification number

Signature

Signature

*Your payment information will be used to set up a Direct Debit in accordance with the terms and conditions of the Direct Debit Guarantee. If you are not satisfied with the service, please contact your bank or building society. Please do not use this form to request a refund of any payment. Please do not use this form to request a refund of any payment.

Special offer: 40% saving on the cover price. Spread the cost and pay just £16.20 every 6 issues by Direct Debit*. Receive every issue delivered direct to your door with free UK delivery.

OTHER PAYMENT METHODS

☐ UK cheque/credit/debit card - £47.25 for 14 issues, saving 25%

☐ Europe int'l rate - £66 for 14 issues

☐ Rest of world - £70 for 14 issues

☐ enclose a cheque made payable to Immediate Media Co Ltd for £

Use ☐ Mastercard ☐ Maestro ☐

Card no

Issue no

Valid from

Expiry date

Signature

Date

If card no./expiry address is different, please supply full order history (0844 844 9767)

OVERSEAS Please complete the order form and send to:
BBC Focus PO Box 279, Sittingbourne, Kent ME9 8DF

*Offer ends 10 April 2017. 40% saving is only available to UK residents paying by Direct Debit. Your subscription will start with the next available issue.

SPECIAL
SUBSCRIPTION
OFFER

TAKE ONE SMALL STEP...

PLEASE
JUNE
FOP306*

SPECIAL SUBSCRIPTION OFFER

SAVE 40% ON THE COVER PRICE

SPREAD THE COST AND PAY
JUST £16.20 EVERY 6 ISSUES
BY DIRECT DEBIT*

RECEIVE EVERY ISSUE DELIVERED
DIRECT TO YOUR DOOR WITH
FREE UK DELIVERY

...AND SAVE 40%

WHEN YOU SUBSCRIBE TODAY*

ONLINE
www.buysubscriptions.
com/FOP306

BY PHONE
0844 844 0257

BY POST
FREEPOST IMMEDIATE MEDIA
(please write in capitals)

*Calls to this number will cost 7p per minute plus your telephone company's access charge. Lines open weekdays 9am-8pm and Saturdays 9am-1pm. If calling from overseas, please call +44 1795 414 000.

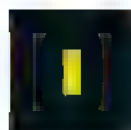


ILLUSTRATION BY JIM

GENETIC GOLDRUSH

Genetic testing is cheaper than ever. Companies are lining up to sell wine, shoes, fitness plans and more – all tailored to your DNA. But just how feasible are their claims?

WRITER: KAT ARNEY



In less than two decades, the science of human genomes is shedding the genetic make-up of individuals and populations has changed beyond

recognition. The first full human genome sequence took 10 years and cost nearly \$4 billion a year (in 1991 prices). Today you can spruce a basic pop of the post-analytic expression of a few weeks detailing thousands of variations within your DNA linked to traits, health and heritage, at a fraction of the cost.

Unsurprisingly, enterprising companies have been quick to jump on the genomic bandwagon, offering everything from fitness plans to personalized wine houses based on your genes. But just how possible is to get such detailed information from a glob of your saliva?

DIRECT TO YOUR DOOR

The story of direct-to-consumer (DTC) genetic testing really starts in the early

2000s. At this time, relatively little was known about how small differences in DNA sequences between people – known as single nucleotide polymorphisms, or SNPs (pronounced snips) – mapped on to disease risk or physical traits such as height, weight or taste preferences.

Meanwhile, companies were popping up offering personalized advice on supplements based on leaving a handful of SNPs. Given the lack of solid scientific evidence linking SNPs to character traits, these were dismissed by the authorities as being medically unproven and ambiguous.

By the middle of the decade, the gene testers had started to wise up. Rather than purporting to offer any kind of medical advice or diagnosis, which would have landed them out of regulatory bodies such as the U.S. Food and Drug Administration (FDA), they now claimed to provide their SNP tests purely for informational and educational use. By 2009, more than 500 SNPs had been reliably linked to the risk of diseases such as cancer, and this

was growing year-on-year. Anyone with a burning biological curiosity and a thousand dollars to spare could now sign up to 'get their genomes done'. Yet despite their growing popularity, when experts analysed the results of these tests they found them to be misleading or even just plain wrong, driven by deceptive marketing rather than sound science.

Put off by regulatory unknowns and a limited consumer base, many of the original SNP-based personalised genetics firms closed down or sold out to larger firms. But there have been a few survivors, and these companies continue to link SNPs to a wide range of disease risks, physical traits and ancestry. And as the pace of technology has accelerated and costs have plummeted, the genetic marketplace is opening up once again.

GENETICALLY TAILORED DIET

One of the big boom areas is in genetic ancestry services, with companies offering to find your long-lost genetic relatives and trace your roots around the globe. Some of them even tell romantic stories of ancient tribes, fierce barbarians or sophisticated

"THERE'S VERY LITTLE HARD EVIDENCE THAT A GENETICALLY-TAILORED DIET IS ANY MORE EFFECTIVE THAN A GENERIC ONE"

BELOW: A printed copy of the human genome fills a whole book.

RIGHT: A chip containing DNA is loaded into a machine for analysis.

artists lurking up the ancestral family tree.

It's certainly possible to pin genetic heritage to certain parts of the world, particularly for populations rather than individuals (though even then it's a relatively imprecise science), as well as figuring out what percentage of your genome came from Neanderthals. But many scientists working in the field of human genetics and evolution are less convinced. For example, researchers from the Molecular and Cellular Evolution Laboratory at University College London have investigated and

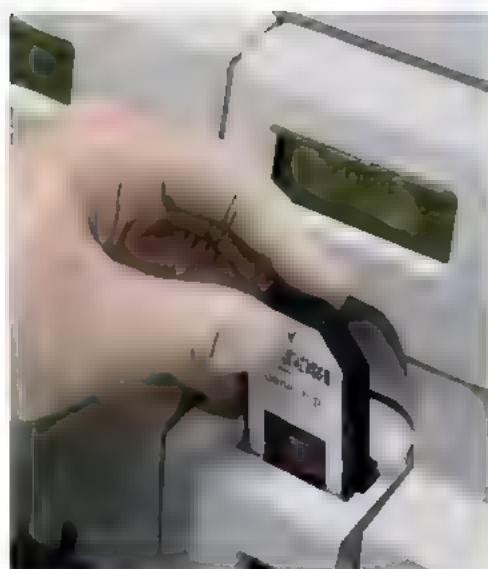
debunked the more dubious claims as little more than "genetic astrology". They argue that the complex patterns of human mating and migration make it tricky to tease apart the tangled genetic threads in each of us with any degree of accuracy.

The other hot topic in DTC testing comes under the broad banner of 'lifestyle'. Companies now offer the chance to 'hack your body' and boost your human potential, with all kinds of dietary and fitness advice tailored to your personal combination of certain SNPs. Some recommend combinations of genetically selected vitamins and dietary supplements, while others even offer personalised meals delivered direct to your door. But although these tests all claim to be supported by science – and while it's true that the SNPs they test for have been linked to weight, metabolism or other physical traits in large studies – there's actually not very much hard evidence available to suggest that following a genetically-tailored diet and fitness plan is more effective than following a generic one.

In fact, a large randomised controlled trial carried out by scientists at University College London and published in 2015 showed that giving people a weight loss programme alongside information about their personal version of a gene called FTO – which is associated with body weight – made them more likely to think about losing weight, but wasn't any more effective than the programme alone.

Another study showed no change in behaviour, at least in the short term, for people who were given genetic information about their risk of type 2 diabetes – although on the plus side there was no increase in worry or anxiety either.

"My feeling is that [DTC tests use] quite a clever marketing strategy," says Dr Caroline Wright, programme manager for the UK's Deciphering Developmental Disorders study and scientific lead at Genomics England. "I think the science behind some of these things is going to be tenuous. There are research papers that link variations in DNA with certain attributes, but it doesn't necessarily mean that if you test that particular variant in a particular person it will be predictive for what they like or what they can do."



EXOME DATA, EXOME PROFILE

Taking advantage of the ever-shrinking cost of DNA sequencing, DTC companies are now moving on from SNPs and taking a deeper look at the human genome. The next step is exome sequencing – reading the entire genetic recipe of all 20,000 genes in the genome, without the misleadingly named 'junk' DNA that lies in-between.

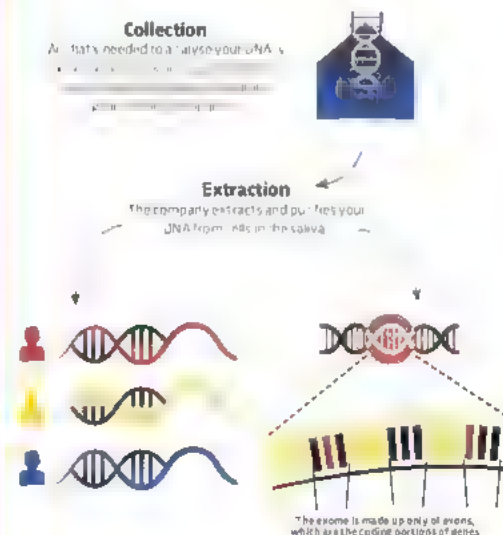
The first firm into the exome marketplace is Helix, backed by DNA technology giant Illumina. Based on the principle of 'sequence once, query often', Helix plans to store customers' exome data and allow them to access it through an app store, with third-party partners offering gene-matched products ranging from health analysis to lifestyle advice.

The first product on offer is Geno 2.0, which is an ancestry analysis package that's produced in association with National Geographic. Further partners are in the process of signing up, including a range of academic institutions such as Duke University and the Mayo Clinic. On the less serious side is Vinome, which offers customers regular deliveries of genetically-matched fine wines with "a little science and a lot of fun".

Whether Helix's exome-and-app approach offers anything more than the SNP-based ancestry or diet and wellness tests remains to be seen. The thornier issue will come if Helix offers analysis of genes involved in disease. Not only does this skirt the line with regulatory agencies such as the FDA, which demands that medical tests are only available to

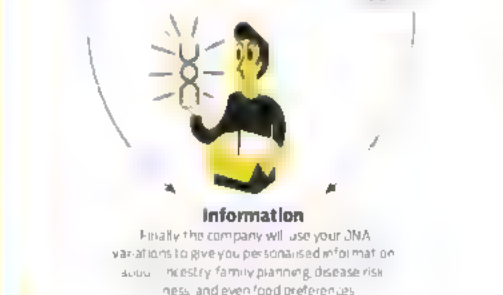
MINING THE GENOME

Personalised genetics companies use two main techniques to quickly and cheaply analyse your DNA. Here's how they compare...



SNPs
The quickest way to look for DNA variations between people is to find single nucleotide polymorphisms (SNPs). Each SNP corresponds to a difference in a single DNA building block, or nucleotide, the letters A, C, G and T – and some of these SNPs have been linked to particular health and lifestyle traits.


Exome sequencing
Rather than look at individual DNA letters, exome sequencing involves reading all of the DNA that codes for our 20,000 genes. The exome is only 1.5 per cent of the human genome, but contains more than 85 per cent of the genes. This technique is more comprehensive than SNP analysis, but a so more expensive.



Information
Finally the company will use your DNA variations to give you personalised information on ancestry, family planning, disease risk, and even food preferences.



DIET

[illegible][illegible]

SKINCARE

1. *What are the main components of a healthy skin barrier?*

2. *How does the skin barrier function to protect the body?*

3. *What are the signs and symptoms of a compromised skin barrier?*

4. *What are the common causes of a compromised skin barrier?*

5. *What are the treatment options for a compromised skin barrier?*

6. *How can you prevent a compromised skin barrier?*

7. *What are the benefits of a healthy skin barrier?*

8. *What are the risks of a compromised skin barrier?*

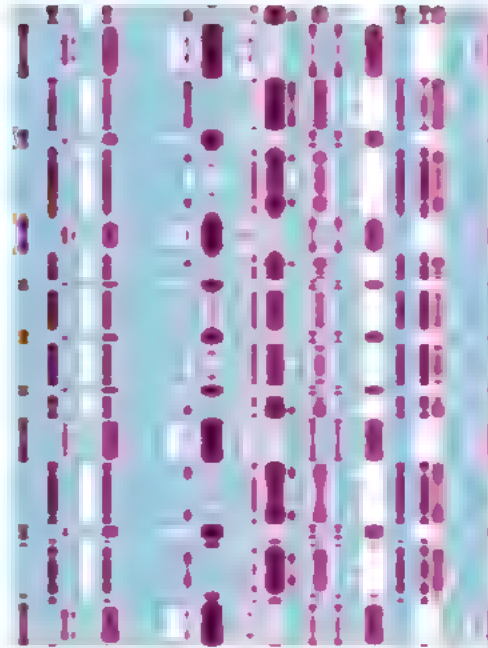
9. *What are the latest research findings on skin barrier health?*

10. *What are the future directions for skin barrier research?*

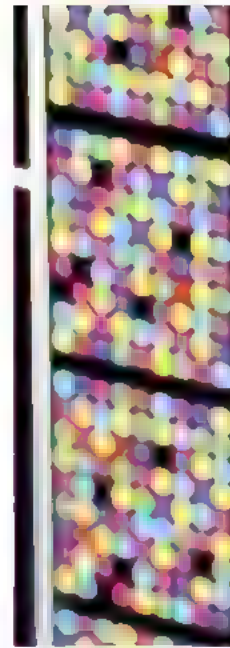


PETS

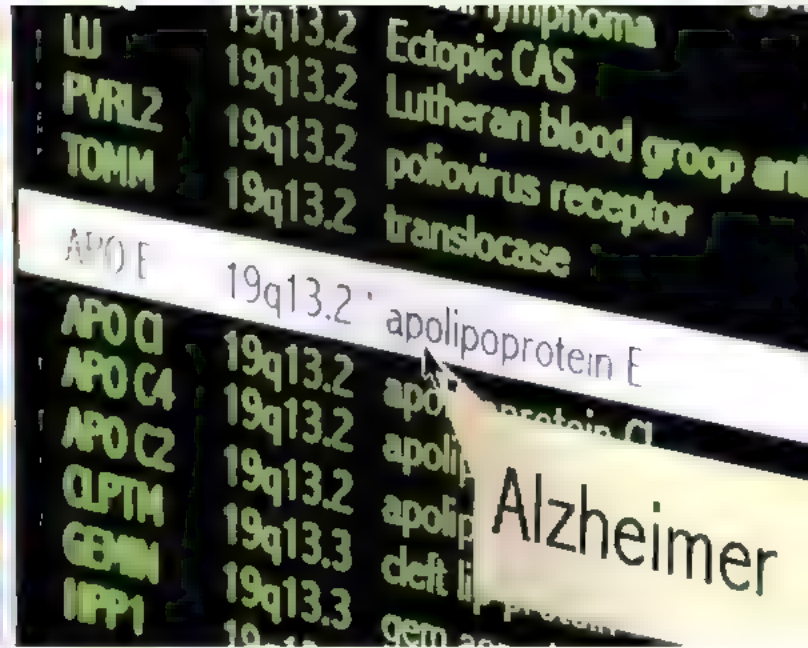
1. 狗 (dog) 2. 猫 (cat) 3. 鸟 (bird) 4. 鱼 (fish) 5. 兔 (rabbit)
 6. 猪 (pig) 7. 牛 (cow) 8. 羊 (sheep) 9. 马 (horse) 10. 鹿 (deer)
 11. 熊 (bear) 12. 狼 (wolf) 13. 狐狸 (fox) 14. 刺猬 (hedgehog) 15. 蛇 (snake)
 16. 乌龟 (turtle) 17. 青蛙 (frog) 18. 蟾蜍 (toad) 19. 蝴蝶 (butterfly) 20. 蜜蜂 (bee)
 21. 蚂蚁 (ant) 22. 蜘蛛 (spider) 23. 蜈蚣 (centipede) 24. 蝎子 (scorpion) 25. 蛇 (snake)



Holmes declined to speak, thus saying that their service will only occur here in the U.S. in 2011 and that there are no imminent plans to bring it to the U.K.



ABOVE A DNA
sequence reveals the
presence of ApoE, a
genetic marker for
Alzheimer's.



Yet for all the excitement, a Dark of night tech apex is lurking: the constant genomic revelations in the same issues that have won us digital privacy have lost us our own privacy and control of personal information. A person who gets asked for the data. Whichever way some information is captured, a person is likely to be a harness or a slave for most people at a time when it is imperative to encourage the public to engage. If privacy is it, sooner have to raise a lot of a lot. But, weighing the cost of a genomic era is more a cost than it is answers.

"THE SAME ISSUES THAT HAVE ALWAYS DOGGED GENETIC TESTING REMAIN, PARTICULARLY AROUND PRIVACY AND CONSENT"

Information about
an entry's fitness and what
kind of place it occupies might
also be linked with
whether it is a yeast or a
saccharine, to brew
rather than to brew
beer (see Figure 1).
Although this does not early on
fully save W_{fit} it does not
immediately wash it
out of the game
either. W_{fit} is a very
generalized and
flexible, and some of them
can vary.

[illegible]

Kat Arney is a professional speaker and author of *How to Work from Home*. She is a frequent speaker at conferences and seminars, and has been featured in *Entrepreneur* magazine and *Forbes* magazine. She is also a frequent contributor to *Entrepreneur* magazine and *Forbes* magazine.



with
: Jeff Forshaw and Brian Cox :
GUIDE TO THE COSMOS



Part 1 of 4

THE UNIVERSAL FABRIC

To understand the cosmos, we first need to get to grips with the nature of space and time. And when we start to do that, some strange ideas emerge...

About this series

In this exclusive four-part series, physicists Jeff Forshaw and Brian Cox introduce us to the biggest ideas in modern physics and cosmology. What is the nature of time? What is everything made from? What happened before the Big Bang, and how will the Universe end? We'll delve into the deepest questions concerning the very essence of space, time, matter, and reality itself.

Here's a strange idea: it is impossible to catch up with a beam of light. Light travels at 300 million metres every second, but if you chased after it at 299 million m/s, it would still be receding from you at 300 million m/s, not at the 1 m/s that you might expect (strictly speaking, the light should be travelling through empty space). That crazy-sounding idea comes from Albert Einstein, and is the bedrock of his Special Theory of Relativity.

CHANNEL
TWO

ILLUSTRATION: JAMES HARRIS



"Time does not tick at a steady rate across the Universe – in some places it ticks faster"

● The implications of Einstein's ideas are enormous. For example, it means that time does not tick at a steady rate across the Universe – in some places it ticks faster than in others, and it becomes possible for people to age at different rates depending on where they are and what they are doing.

Perhaps the most dramatic example of this is the 'twin paradox', where an astronaut departs from Earth, leaving her twin brother behind. She zips around for a bit in her super-fast spaceship and then lands back on Earth a year later, only to find that many more years have passed. Back home – and her brother is now an old man. This is exactly the kind of weirdness that must be true if Einstein is right – though we aren't aware of it in our everyday lives because we can't

zip around fast enough, and so are tricked into thinking time is more constant than it actually is.

The fact that a moving clock does not tick as fast as a stationary one is actually quite easy to demonstrate. First, imagine a clock made from two parallel mirrors, between which a particle of light or 'photon' bounces back and forth (see 'The key idea' right). Imagine you have one of these light clocks in your hand, and that you can watch it perfectly as it goes up and down, measuring the time it takes as a way of measuring time. Now imagine that a friend also has one of these clocks, but that she's moving horizontally.

From your point of view, her photon traces out a zig-zag path, as it bounces from one mirror to the other and back again, travelling further during each round trip than the photon in your clock.

There's nothing controversial in what we just said. Here comes the weird bit. Because, according to Einstein, the light bouncing in your friend's clock is travelling at the same speed as the light in your clock, the light in your friend's clock must take longer to bounce between the mirrors. In other words, your friend's clock is running slower than yours.

This remarkable conclusion might sound like a special feature of light clocks. But it isn't – it is a feature of all clocks. To understand why we need to introduce Einstein's second crucial idea – an idea first introduced by Galileo Galilei in the early 1600s –

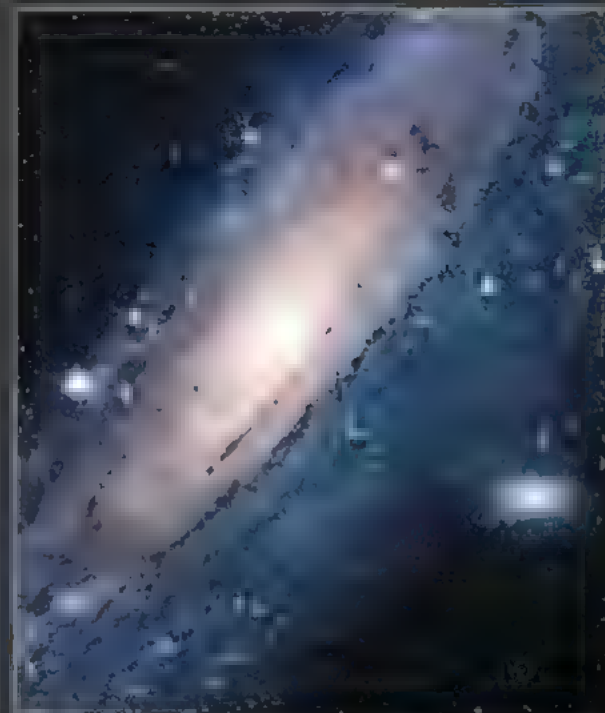
THE SHIP AND THE BUTTERFLIES

Galileo imagined a ship moving at fixed speed over a calm ocean. Inside this ship, below decks, is a host of flies, butterflies and other small flying animals. He noted that, from observations of the creatures made only inside the ship, it would be impossible to tell whether the ship was moving or standing still. The idea that experiments and observations made in a laboratory at rest give exactly the same results as those made in a laboratory that's moving uniformly is called the principle of relativity, and Einstein followed Galileo in assuming it to be true. According to this principle, if a moving light clock is ●

The key idea

HOW MOTION SLOWS THE PASSAGE OF TIME

Imagine a clock made from two parallel mirrors with a photon (particle of light) bouncing between them. If the mirrors are placed the correct distance apart, the photon will take one second to make a round trip between them (A). If the clock is moving horizontally, however, the photon will trace out two sides of a triangle, travelling a greater distance (B). Since the speed of light is constant, the photon will take longer to bounce between the moving mirrors, and – from our point of view – each second on the moving clock will take longer than on the stationary clock.



The Andromeda galaxy – 50 years away if you could travel at 99.9999999 per cent of the speed of light

Glossary

LIGHT CLOCK

A type of clock where light bounces between a pair of mirrors. These provide a useful way to think about Einstein's Special Theory of Relativity, which says a moving clock will run slower than a stationary one.

TWIN PARADOX

The puzzle that two identical twins should age at different rates depending on how they move. There's actually no paradox – Einstein's Special Theory of Relativity explains why this is true.

NEUTRON STAR

These astonishingly dense dead stars have a mass roughly equal to the Sun, but squeezed into the size of a city. Spinning neutron stars emit pulses of radio waves, which can be used by astronomers to test Einstein's theory of gravity.

PRINCIPLE OF RELATIVITY

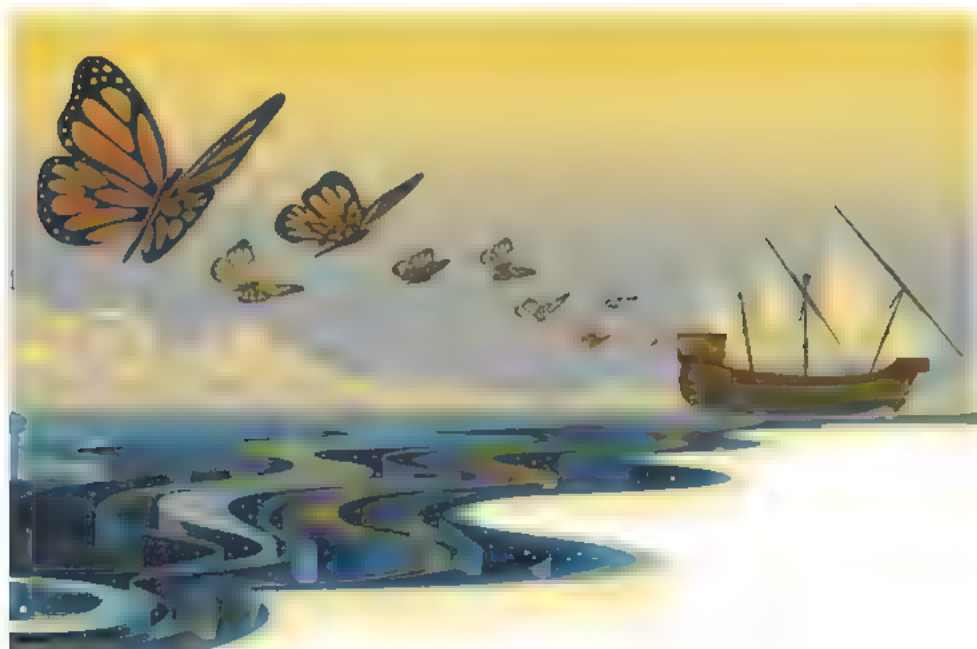
The idea that there is no way to define 'at rest' in any absolute sense. In other words, all motion is relative.

SPACE-TIME

Modern physics combines the three dimensions of space and the one dimension of time into this single four-dimensional entity.

GRAVITATIONAL WAVES

A moving ripple in the fabric of space-time that causes lengths to change and clocks to tick at different rates as it passes by.



• space and time let's think about the possibility that the paths or lives of those who lived farther from America's battle lines were nearly the same as if they lived in space. If you travel 2.5 light years, then you've taken 2.5 years to get there. But as we've just seen, it will appear 50 years. This opens up a lot of interesting possibilities for the relation to America's 50th year.

11. *Other worlds* *There are many*
forevers *and* *that* *that* *that* *the*
destiny *is* *careless* *like* *the*
things *is* *the* *the* *the* *the*
to say *the* *the* *the* *the* *the*
as *in* *light* *years* *We* *are*
at *the* *the* *the* *the* *the*
people *on* *Earth*

WHAT GOES UP...

Ernst was a very able writer. His 5,000 to 10,000 letters to his friends and family in 1905 are still of great value. But there was more to him than his letters. In 1905 he wrote a paper on the theory of relativity which was not published until 1907. He wrote it within the next 200 years after it was first known. With this general theory of relativity, Einstein,

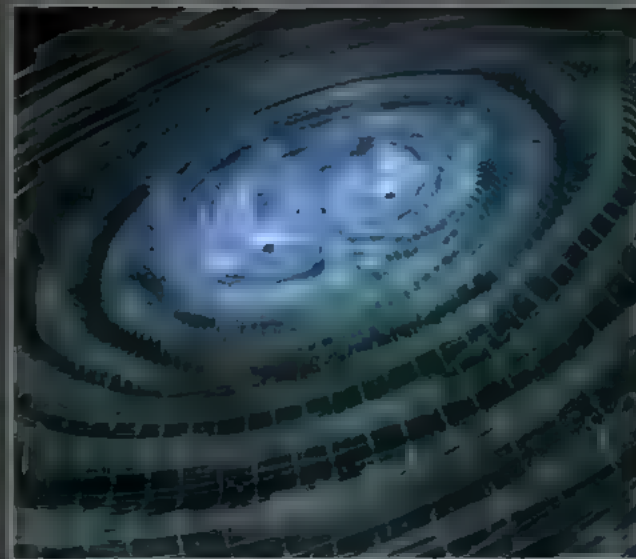
“Einstein made the bold claim that a clock placed at sea level ticks more slowly than one placed at the top of a mountain”

made the bold claim that a rock placed at sea level takes more slowly than one placed at the top of a mountain. In other words, air passes at different rates depending on its strength of gravity (which decreases as you get farther from Earth's core).

We can appreciate why this is a slight betrayal — $\langle g \rangle$ and $\langle g^2 \rangle$ are not the same as $\langle g^2 \rangle$ and $\langle g \rangle$. As $\langle g \rangle$ goes to 1, he trapped a massive ball and $\langle g^2 \rangle$ got bigger. From the examining floor of Pisa, and continuing to the headwaters of the great $\langle g \rangle$ at the same time, $\langle g^2 \rangle$ ad showed that all things were created at the same time at the same rate. This feature of gravity is an interesting one — a scientist says there's no

There is a difference between the experiment on beards in doing it inside a space station or orbiting at 1g where sequence is by gravity and μ on the flat surfaces; in the words that free surface and acceleration are essentially the same.

So how does this link in with Einstein's ideas about gravity? Let's return again to the twin paradox. When the astronaut twin fires up her rockets and accelerates her spaceship,



Weekend view - looking in the future at some of the main events in Britain's life on

her experience is the same as someone who is under the influence of a gravitational pull. So, if we were already sick, but not quite there, say, than her brother's, might this part of her journey and her experience be important to that? So, her experience gravitally will come to her after the summer, clocks that are under the influence of stronger gravity.

Two new subatomic ideas have been tested in experiments at SLAC. Some of the best evidence comes from studies of the pair of particles produced in electron-positron annihilation. In a recent experiment, the first observation of the existence of a pair of black holes in the world of particle physics, which orbited each other, Fries came up with the idea that they should appear as the least luminous pair of spatially separated or separated white-light sources in the sky.

If the use of new cars saves the
omission of them, gravel and waves
causes the stars to fall away
inward. Astronomers measuring these
at Jodrell Bank in the UK have used

radar waves emitted by these stars to calculate that they spiral inward at a rate of six inches a day. With black holes, he's talking in a different unit—they fall into the gravitational ripples a space of time have been there. The amount of time has by our clock. Or, another way to say it, Earth and the stars are in a work world for which the stars live about 100 years and the black holes live about 100,000 years. The fact that the black holes take so long to fall in makes it more likely that they will be found. The black holes that are the most massive, he says, are the ones that are the most likely to be found.

Although it is a highly sensitive subject, we do not think it is a subject that is more fundamental than the question of whether we should also be concerned about the status of the Japanese in the United States. I agree that the Japanese are a very important part of the United States, but I do not think that the question of whether we should be concerned about the status of the Japanese is a more fundamental question than the question of whether we should be concerned about the status of the Japanese in the United States.

and the presence of the two aspects of modern physics in contemporary art, we will find the scientific argument theory. The arguments are abundant, even wonder.

"Einstein's theory forces us to conclude that, like time, distances in space are also subjective."

Jeff Forshaw is professor of physics at the University of Michigan. He is also a member of the National Academy of Sciences and the American Academy of Arts and Sciences. He is the author of several books, including "The Physics of the Future" and "The Physics of the Cosmos".

Brian Cox *Executive Director*

DISCOVER MORE

L... .. H
J... .. Why L089

L = m... ..

... ..
A... ..

Managing your staff leave has just become easier.

WhosOff delivers a streamlined solution to the enduring problem of managing staff leave. It's so easy to use, you can be up and online in under 10 minutes. No programming or IT background necessary. No time to focus on your other duties.



START YOUR FREE TRIAL TODAY

our no obligation free trial, no credit card required!

an extra month free on your trial: WHOSOFT

WHOSOFT
staff leave management made easy



HELEN CZERSKI, *DECIIPHERING HAIR CARE*

"THE SHIMMER OF A SUNSET OFF THE OCEAN MIGHT JUST HAVE SOMETHING TO SAY ABOUT YOUR HAIR"



Looking down at me from just over the wall was a glass-fronted model, crowned with a shimmering fountain of impossible hair. A selection of different hairbrushes located to my left were laid out like a toolkit primed for the pursuit of perfection. My own wayward mane kept falling into my eyes, betraying my utter ambivalence towards the hair care trade. But the hair scientist that we had come to visit was determined to extract my opinion anyway. He was gesturing at the shelves of tresses. The hair perfectly combed and displayed under bright light. He was asking a question. "Which one of these do you think is in the best condition?" I was clearly about to fail the first test of hair care because all of the tresses looked exactly the same to me. And then just before I admitted my ignorance, my brain made the link with the ocean.

The brightly Pacific Ocean was my companion when I made the switch from my PhD topic to oceanography, and was introduced to the mysteries of our planet's oceans. At the Scripps Institution of Oceanography in La Jolla, California, where I was based, the beach was the backdrop to everything. Every Friday afternoon, the scientists would gather at a wooden beach club to watch the sunset over the ocean and drink beer. It was here that I first noticed the sparkle upon the water's surface when the Sun was low, roaring out directly towards me. It's poetically known as a 'glitter path' as sunlight sparkles off the ocean into your eyes. And on this very same cliff top, decades later, two physicists had worked out that the glitter path carried information.

You can observe a glitter path on rivers and lakes as well as the ocean, whenever the Sun is low in the



sky. And they vary in width. Sometimes you see a wide line close to the Sun, which becomes narrower as it comes in towards the shore. And sometimes it bulges in the middle or near the coast. The water isn't a perfect mirror, because it isn't completely flat. If it was then you would just see an upside-down image of the Sun reflected in its surface. But that's rare. A glitter path is made up of thousands of individual sparkles, as different waves catch the Sun's image. Those waves can be slightly off to the side, or in front of, or behind the perfect image, and you see the sparkles as different waves catch the light coming from the Sun and redirect it to you. So the rougher the water is, the wider and longer the glitter path, because there are lots of different places that a wave can be and still bounce sunlight towards you. A narrow glitter path tells you there's calmer water. Even though you can't see the individual waves – they're relatively small and they could be miles away – the glitter pattern is providing a

measure of surface roughness.

And so back to the hair. An individual strand of hair is covered with tiny scales. On healthy hair, the scales lie down flat, but on damaged hair they stick out at all sorts of funny angles. One of the hair tresses was reflecting the bright light in a very narrow way, and the others were wider. The same principle was at work both here and on the ocean – I couldn't see the



scruffed-up scales on the damaged hair, but I could infer their existence from the shine pattern. I pointed at the one with the narrow shine pattern, and the hair scientist beamed at me. Maybe there's hope for me yet in the world of hair care. ☺

Dr Saunders strikes back

Psychiatrist suffers stroke, then analyses symptoms to help others

Dr Tony Saunders always looked after his health, so it seemed doubly unfair when he collapsed with a major stroke in the gym.

Tony's family were worried that he could die, as stroke takes a life every 13 minutes in the UK. And it's the leading cause of severe adult disability.

Fortunately with excellent treatment, Tony eventually returned to work.

But Tony noticed that discussing his stroke made him anxious – he even started stuttering.

As a psychiatrist, he identified this as post-traumatic stress disorder. He then realised that, on top of his medical training, he now had valuable first-hand experience of stroke.

So Tony struck back by overcoming his anxiety, and giving talks to medical students. As a result,

a new generation of doctors are supporting their patients with powerful new techniques.

This is Tony's legacy. And now you can strike back against stroke too, by leaving us a legacy of your own.

Stroke
association

Together we can conquer stroke.

Call 020 7566 7505 email legacy@stroke.org.uk or visit stroke.org.uk/legacy

Registered office: Stroke Association House, 2-40 City Road, London EC1Y 2PR. Registered as a Charity in England and Wales (No. 274057) and in Scotland (SC257766). Also registered as a Non-Profit Organisation (CIS 3605). Ltd of Wales (No. 882) and Jersey (No. 368). Stroke Association is a Company Limited by Guarantee in England and Wales (No. 12174).



DR ALASTAIR GUNN
Asthma
asthmaexpert

ALEXANDRA CHEUNG
Lawyer
mumsaid

DR PATTY BENTLEY
Lifestyle
lifestyleauthor

PROF ALICE CROUDRY
Psychology
mumsaid

PROF MARK LOREN
History
mumsaid

EMMA OTTE
Fitness
mumsaid

DR HELEN SCALES
Lifestyle
mumsaid

DR CHRISTIAN JACQUE
Lifestyle
mumsaid

EMMA DAVIES
Lifestyle
mumsaid

LUCY VILLAZON
Lifestyle
mumsaid

DR ANASTAS PRASAD
Lifestyle
mumsaid

PROF ROBERT MATTHEWS
Lifestyle
mumsaid

YOUR QUESTIONS ANSWERED





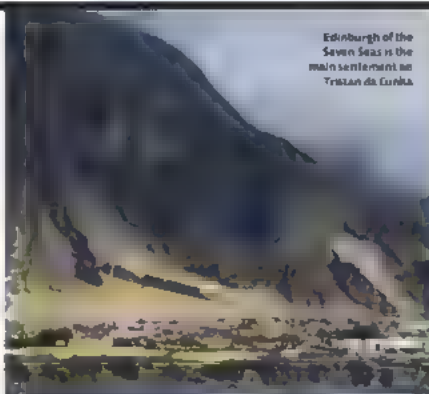
From left to right: preserved penis bone of domestic dog, coati/mundi, kinkajou and red fox

Why don't humans have a penis bone?

CLAIRE RUSSELL, BILKESIDE

The penis bone or baculum is common to most of placental mammals but by no means all of them. It seems to have evolved independently in different mammalian lineages. It has also subsequently been lost in many cases. Among primates, humans are the only ones without a baculum, although it's still in gorillas and chimpanzees.

The baculum allows prolonged penetration and it is normally only present in animals that mate for longer than three minutes. Lengthy sex sessions are an adaptation to maximise the male's chance of impregnating the female. Humans evolved monogamy as a reproductive strategy, which along with other social rules reduces the risk of females mating with rival males. Men can therefore get away with shorter copulation times. **W**



Edinburgh of the Seven Seas is the main settlement on Tristan da Cunha

What's the most remote inhabited place on Earth?

JESSIE BAKER, CARLOW

That record normally goes to the Tristan da Cunha islands in the South Atlantic, which are 2,415km from Saint Helena. But they aren't the most remote if you consider Tristan da Cunha Island itself and Gough Island as part of the same archipelago. The two islands are both inhabited and only 359km apart from each other. Discounting those, the next most remote is Easter Island, which is 2,075km from the nearest other inhabited spot, Pitcairn Island. **W**

IN NUMBERS

70

36

Why do our ears ring after we listen to loud music?

MEREDITH BAILEY, HORSHAM



Loud sounds can damage the hair cells in your cochlea of your inner ear. This causes some degree of hearing loss and your brain tries to compensate by turning up the gain control so the signals from remaining healthy hair cells are amplified. This also amplifies external noise in the signal, which we hear as a ringing. Prolonged or repeated exposure to loud noises can damage or kill the hair cells for good. **W**

What's the slowest a plane can fly?

LUCIE COLTMAN, GLOUCESTER

Technically this is the so-called 'stall speed', where air passes over the wings fast enough to sustain altitude, and for small planes this can be less than 50km/h (31mph). But at such low speeds, the aircraft is easily destabilised and could fail to leave the runway. So for safety and stability at take-off commercial airliners must achieve substantially higher speeds exceeding around 250km/h (155mph). **W**



THE THOUGHT EXPERIMENT

WHAT WOULD HAPPEN IF THE EARTH STOPPED SPINNING?



1. Sudden stop

If the planet stopped suddenly, everything on the surface would be destroyed, as the atmosphere, oceans and anything not nailed down kept spinning. Even braking to a halt over a minute would mean everything experienced a sideways deceleration of three-quarters of Earth's gravity, so 'down' would feel like it was at an angle of 38° from the vertical. That's enough to knock over most buildings.



2. Changing continents

If it slowed down over several years, it would still be a disaster. Without centrifugal force, the oceans would move towards the poles, dropping ocean depth by 8km around the equator. Since this is less than the depth of the ocean there, Earth's water would be divided into two huge polar oceans separated by a belt of land in the middle. Everything north of Spain would be underwater, as well as all of Antarctica.



3. Bake and freeze

Once Earth doesn't spin on its own axis, a day lasts as long as a year. Everywhere receives six months of daylight, gradually heating up the planet to well over 100°C. The huge central continent would get the hottest and any remaining lakes and rivers would boil away and be blown to the poles by fierce winds. Even primitive life would only be possible along a narrow strip at the coast.

Why is Jupiter stripy?

OLIVER FLIPPANCE, KENILWORTH

Jupiter's stripes or 'bands' are caused by differences in the chemical composition and temperature of the atmospheric gas. The light-coloured bands are called 'zones' and show regions where the gas is rising. The dark-coloured bands are called 'belts' and show where the gas is sinking. It used to be thought that the only cause for these bands was the strong atmospheric winds coupled with strong convection cells circulating material between different layers of the atmosphere. However, it is now thought that Jupiter's moons also play an important role in making Jupiter stripy by tugging on the planet's atmospheric convection cells. **W**



PHOTOGRAPHS: (1) NASA; (2) NASA; (3) NASA; (4) NASA; (5) NASA; (6) NASA; (7) NASA; (8) NASA; (9) NASA; (10) NASA; (11) NASA; (12) NASA; (13) NASA; (14) NASA; (15) NASA; (16) NASA; (17) NASA; (18) NASA; (19) NASA; (20) NASA; (21) NASA; (22) NASA; (23) NASA; (24) NASA; (25) NASA; (26) NASA; (27) NASA; (28) NASA; (29) NASA; (30) NASA; (31) NASA; (32) NASA; (33) NASA; (34) NASA; (35) NASA; (36) NASA; (37) NASA; (38) NASA; (39) NASA; (40) NASA; (41) NASA; (42) NASA; (43) NASA; (44) NASA; (45) NASA; (46) NASA; (47) NASA; (48) NASA; (49) NASA; (50) NASA; (51) NASA; (52) NASA; (53) NASA; (54) NASA; (55) NASA; (56) NASA; (57) NASA; (58) NASA; (59) NASA; (60) NASA; (61) NASA; (62) NASA; (63) NASA; (64) NASA; (65) NASA; (66) NASA; (67) NASA; (68) NASA; (69) NASA; (70) NASA; (71) NASA; (72) NASA; (73) NASA; (74) NASA; (75) NASA; (76) NASA; (77) NASA; (78) NASA; (79) NASA; (80) NASA; (81) NASA; (82) NASA; (83) NASA; (84) NASA; (85) NASA; (86) NASA; (87) NASA; (88) NASA; (89) NASA; (90) NASA; (91) NASA; (92) NASA; (93) NASA; (94) NASA; (95) NASA; (96) NASA; (97) NASA; (98) NASA; (99) NASA; (100) NASA; (101) NASA; (102) NASA; (103) NASA; (104) NASA; (105) NASA; (106) NASA; (107) NASA; (108) NASA; (109) NASA; (110) NASA; (111) NASA; (112) NASA; (113) NASA; (114) NASA; (115) NASA; (116) NASA; (117) NASA; (118) NASA; (119) NASA; (120) NASA; (121) NASA; (122) NASA; (123) NASA; (124) NASA; (125) NASA; (126) NASA; (127) NASA; (128) NASA; (129) NASA; (130) NASA; (131) NASA; (132) NASA; (133) NASA; (134) NASA; (135) NASA; (136) NASA; (137) NASA; (138) NASA; (139) NASA; (140) NASA; (141) NASA; (142) NASA; (143) NASA; (144) NASA; (145) NASA; (146) NASA; (147) NASA; (148) NASA; (149) NASA; (150) NASA; (151) NASA; (152) NASA; (153) NASA; (154) NASA; (155) NASA; (156) NASA; (157) NASA; (158) NASA; (159) NASA; (160) NASA; (161) NASA; (162) NASA; (163) NASA; (164) NASA; (165) NASA; (166) NASA; (167) NASA; (168) NASA; (169) NASA; (170) NASA; (171) NASA; (172) NASA; (173) NASA; (174) NASA; (175) NASA; (176) NASA; (177) NASA; (178) NASA; (179) NASA; (180) NASA; (181) NASA; (182) NASA; (183) NASA; (184) NASA; (185) NASA; (186) NASA; (187) NASA; (188) NASA; (189) NASA; (190) NASA; (191) NASA; (192) NASA; (193) NASA; (194) NASA; (195) NASA; (196) NASA; (197) NASA; (198) NASA; (199) NASA; (200) NASA; (201) NASA; (202) NASA; (203) NASA; (204) NASA; (205) NASA; (206) NASA; (207) NASA; (208) NASA; (209) NASA; (210) NASA; (211) NASA; (212) NASA; (213) NASA; (214) NASA; (215) NASA; (216) NASA; (217) NASA; (218) NASA; (219) NASA; (220) NASA; (221) NASA; (222) NASA; (223) NASA; (224) NASA; (225) NASA; (226) NASA; (227) NASA; (228) NASA; (229) NASA; (230) NASA; (231) NASA; (232) NASA; (233) NASA; (234) NASA; (235) NASA; (236) NASA; (237) NASA; (238) NASA; (239) NASA; (240) NASA; (241) NASA; (242) NASA; (243) NASA; (244) NASA; (245) NASA; (246) NASA; (247) NASA; (248) NASA; (249) NASA; (250) NASA; (251) NASA; (252) NASA; (253) NASA; (254) NASA; (255) NASA; (256) NASA; (257) NASA; (258) NASA; (259) NASA; (260) NASA; (261) NASA; (262) NASA; (263) NASA; (264) NASA; (265) NASA; (266) NASA; (267) NASA; (268) NASA; (269) NASA; (270) NASA; (271) NASA; (272) NASA; (273) NASA; (274) NASA; (275) NASA; (276) NASA; (277) NASA; (278) NASA; (279) NASA; (280) NASA; (281) NASA; (282) NASA; (283) NASA; (284) NASA; (285) NASA; (286) NASA; (287) NASA; (288) NASA; (289) NASA; (290) NASA; (291) NASA; (292) NASA; (293) NASA; (294) NASA; (295) NASA; (296) NASA; (297) NASA; (298) NASA; (299) NASA; (300) NASA; (301) NASA; (302) NASA; (303) NASA; (304) NASA; (305) NASA; (306) NASA; (307) NASA; (308) NASA; (309) NASA; (310) NASA; (311) NASA; (312) NASA; (313) NASA; (314) NASA; (315) NASA; (316) NASA; (317) NASA; (318) NASA; (319) NASA; (320) NASA; (321) NASA; (322) NASA; (323) NASA; (324) NASA; (325) NASA; (326) NASA; (327) NASA; (328) NASA; (329) NASA; (330) NASA; (331) NASA; (332) NASA; (333) NASA; (334) NASA; (335) NASA; (336) NASA; (337) NASA; (338) NASA; (339) NASA; (340) NASA; (341) NASA; (342) NASA; (343) NASA; (344) NASA; (345) NASA; (346) NASA; (347) NASA; (348) NASA; (349) NASA; (350) NASA; (351) NASA; (352) NASA; (353) NASA; (354) NASA; (355) NASA; (356) NASA; (357) NASA; (358) NASA; (359) NASA; (360) NASA; (361) NASA; (362) NASA; (363) NASA; (364) NASA; (365) NASA; (366) NASA; (367) NASA; (368) NASA; (369) NASA; (370) NASA; (371) NASA; (372) NASA; (373) NASA; (374) NASA; (375) NASA; (376) NASA; (377) NASA; (378) NASA; (379) NASA; (380) NASA; (381) NASA; (382) NASA; (383) NASA; (384) NASA; (385) NASA; (386) NASA; (387) NASA; (388) NASA; (389) NASA; (390) NASA; (391) NASA; (392) NASA; (393) NASA; (394) NASA; (395) NASA; (396) NASA; (397) NASA; (398) NASA; (399) NASA; (400) NASA; (401) NASA; (402) NASA; (403) NASA; (404) NASA; (405) NASA; (406) NASA; (407) NASA; (408) NASA; (409) NASA; (410) NASA; (411) NASA; (412) NASA; (413) NASA; (414) NASA; (415) NASA; (416) NASA; (417) NASA; (418) NASA; (419) NASA; (420) NASA; (421) NASA; (422) NASA; (423) NASA; (424) NASA; (425) NASA; (426) NASA; (427) NASA; (428) NASA; (429) NASA; (430) NASA; (431) NASA; (432) NASA; (433) NASA; (434) NASA; (435) NASA; (436) NASA; (437) NASA; (438) NASA; (439) NASA; (440) NASA; (441) NASA; (442) NASA; (443) NASA; (444) NASA; (445) NASA; (446) NASA; (447) NASA; (448) NASA; (449) NASA; (450) NASA; (451) NASA; (452) NASA; (453) NASA; (454) NASA; (455) NASA; (456) NASA; (457) NASA; (458) NASA; (459) NASA; (460) NASA; (461) NASA; (462) NASA; (463) NASA; (464) NASA; (465) NASA; (466) NASA; (467) NASA; (468) NASA; (469) NASA; (470) NASA; (471) NASA; (472) NASA; (473) NASA; (474) NASA; (475) NASA; (476) NASA; (477) NASA; (478) NASA; (479) NASA; (480) NASA; (481) NASA; (482) NASA; (483) NASA; (484) NASA; (485) NASA; (486) NASA; (487) NASA; (488) NASA; (489) NASA; (490) NASA; (491) NASA; (492) NASA; (493) NASA; (494) NASA; (495) NASA; (496) NASA; (497) NASA; (498) NASA; (499) NASA; (500) NASA; (501) NASA; (502) NASA; (503) NASA; (504) NASA; (505) NASA; (506) NASA; (507) NASA; (508) NASA; (509) NASA; (510) NASA; (511) NASA; (512) NASA; (513) NASA; (514) NASA; (515) NASA; (516) NASA; (517) NASA; (518) NASA; (519) NASA; (520) NASA; (521) NASA; (522) NASA; (523) NASA; (524) NASA; (525) NASA; (526) NASA; (527) NASA; (528) NASA; (529) NASA; (530) NASA; (531) NASA; (532) NASA; (533) NASA; (534) NASA; (535) NASA; (536) NASA; (537) NASA; (538) NASA; (539) NASA; (540) NASA; (541) NASA; (542) NASA; (543) NASA; (544) NASA; (545) NASA; (546) NASA; (547) NASA; (548) NASA; (549) NASA; (550) NASA; (551) NASA; (552) NASA; (553) NASA; (554) NASA; (555) NASA; (556) NASA; (557) NASA; (558) NASA; (559) NASA; (560) NASA; (561) NASA; (562) NASA; (563) NASA; (564) NASA; (565) NASA; (566) NASA; (567) NASA; (568) NASA; (569) NASA; (570) NASA; (571) NASA; (572) NASA; (573) NASA; (574) NASA; (575) NASA; (576) NASA; (577) NASA; (578) NASA; (579) NASA; (580) NASA; (581) NASA; (582) NASA; (583) NASA; (584) NASA; (585) NASA; (586) NASA; (587) NASA; (588) NASA; (589) NASA; (590) NASA; (591) NASA; (592) NASA; (593) NASA; (594) NASA; (595) NASA; (596) NASA; (597) NASA; (598) NASA; (599) NASA; (600) NASA; (601) NASA; (602) NASA; (603) NASA; (604) NASA; (605) NASA; (606) NASA; (607) NASA; (608) NASA; (609) NASA; (610) NASA; (611) NASA; (612) NASA; (613) NASA; (614) NASA; (615) NASA; (616) NASA; (617) NASA; (618) NASA; (619) NASA; (620) NASA; (621) NASA; (622) NASA; (623) NASA; (624) NASA; (625) NASA; (626) NASA; (627) NASA; (628) NASA; (629) NASA; (630) NASA; (631) NASA; (632) NASA; (633) NASA; (634) NASA; (635) NASA; (636) NASA; (637) NASA; (638) NASA; (639) NASA; (640) NASA; (641) NASA; (642) NASA; (643) NASA; (644) NASA; (645) NASA; (646) NASA; (647) NASA; (648) NASA; (649) NASA; (650) NASA; (651) NASA; (652) NASA; (653) NASA; (654) NASA; (655) NASA; (656) NASA; (657) NASA; (658) NASA; (659) NASA; (660) NASA; (661) NASA; (662) NASA; (663) NASA; (664) NASA; (665) NASA; (666) NASA; (667) NASA; (668) NASA; (669) NASA; (670) NASA; (671) NASA; (672) NASA; (673) NASA; (674) NASA; (675) NASA; (676) NASA; (677) NASA; (678) NASA; (679) NASA; (680) NASA; (681) NASA; (682) NASA; (683) NASA; (684) NASA; (685) NASA; (686) NASA; (687) NASA; (688) NASA; (689) NASA; (690) NASA; (691) NASA; (692) NASA; (693) NASA; (694) NASA; (695) NASA; (696) NASA; (697) NASA; (698) NASA; (699) NASA; (700) NASA; (701) NASA; (702) NASA; (703) NASA; (704) NASA; (705) NASA; (706) NASA; (707) NASA; (708) NASA; (709) NASA; (710) NASA; (711) NASA; (712) NASA; (713) NASA; (714) NASA; (715) NASA; (716) NASA; (717) NASA; (718) NASA; (719) NASA; (720) NASA; (721) NASA; (722) NASA; (723) NASA; (724) NASA; (725) NASA; (726) NASA; (727) NASA; (728) NASA; (729) NASA; (730) NASA; (731) NASA; (732) NASA; (733) NASA; (734) NASA; (735) NASA; (736) NASA; (737) NASA; (738) NASA; (739) NASA; (740) NASA; (741) NASA; (742) NASA; (743) NASA; (744) NASA; (745) NASA; (746) NASA; (747) NASA; (748) NASA; (749) NASA; (750) NASA; (751) NASA; (752) NASA; (753) NASA; (754) NASA; (755) NASA; (756) NASA; (757) NASA; (758) NASA; (759) NASA; (760) NASA; (761) NASA; (762) NASA; (763) NASA; (764) NASA; (765) NASA; (766) NASA; (767) NASA; (768) NASA; (769) NASA; (770) NASA; (771) NASA; (772) NASA; (773) NASA; (774) NASA; (775) NASA; (776) NASA; (777) NASA; (778) NASA; (779) NASA; (780) NASA; (781) NASA; (782) NASA; (783) NASA; (784) NASA; (785) NASA; (786) NASA; (787) NASA; (788) NASA; (789) NASA; (790) NASA; (791) NASA; (792) NASA; (793) NASA; (794) NASA; (795) NASA; (796) NASA; (797) NASA; (798) NASA; (799) NASA; (800) NASA; (801) NASA; (802) NASA; (803) NASA; (804) NASA; (805) NASA; (806) NASA; (807) NASA; (808) NASA; (809) NASA; (810) NASA; (811) NASA; (812) NASA; (813) NASA; (814) NASA; (815) NASA; (816) NASA; (817) NASA; (818) NASA; (819) NASA; (820) NASA; (821) NASA; (822) NASA; (823) NASA; (824) NASA; (825) NASA; (826) NASA; (827) NASA; (828) NASA; (829) NASA; (830) NASA; (831) NASA; (832) NASA; (833) NASA; (834) NASA; (835) NASA; (836) NASA; (837) NASA; (838) NASA; (839) NASA; (840) NASA; (841) NASA; (842) NASA; (843) NASA; (844) NASA; (845) NASA; (846) NASA; (847) NASA; (848) NASA; (849) NASA; (850) NASA; (851) NASA; (852) NASA; (853) NASA; (854) NASA; (855) NASA; (856) NASA; (857) NASA; (858) NASA; (859) NASA; (860) NASA; (861) NASA; (862) NASA; (863) NASA; (864) NASA; (865) NASA; (866) NASA; (867) NASA; (868) NASA; (869) NASA; (870) NASA; (871) NASA; (872) NASA; (873) NASA; (874) NASA; (875) NASA; (876) NASA; (877) NASA; (878) NASA; (879) NASA; (880) NASA; (881) NASA; (882) NASA; (883) NASA; (884) NASA; (885) NASA; (886) NASA; (887) NASA; (888) NASA; (889) NASA; (890) NASA; (891) NASA; (892) NASA; (893) NASA; (894) NASA; (895) NASA; (896) NASA; (897) NASA; (898) NASA; (899) NASA; (900) NASA; (901) NASA; (902) NASA; (903) NASA; (904) NASA; (905) NASA; (906) NASA; (907) NASA; (908) NASA; (909) NASA; (910) NASA; (911) NASA; (912) NASA; (913) NASA; (914) NASA; (915) NASA; (916) NASA; (917) NASA; (918) NASA; (919) NASA; (920) NASA; (921) NASA; (922) NASA; (923) NASA; (924) NASA; (925) NASA; (926) NASA; (927) NASA; (928) NASA; (929) NASA; (930) NASA; (931) NASA; (932) NASA; (933) NASA; (934) NASA; (935) NASA; (936) NASA; (937) NASA; (938) NASA; (939) NASA; (940) NASA; (941) NASA; (942) NASA; (943) NASA; (944) NASA; (945) NASA; (946) NASA; (947) NASA; (948) NASA; (949) NASA; (950) NASA; (951) NASA; (952) NASA; (953) NASA; (954) NASA; (955) NASA; (956) NASA; (957) NASA; (958) NASA; (959) NASA; (960) NASA; (961) NASA; (962) NASA; (963) NASA; (964) NASA; (965) NASA; (966) NASA; (967) NASA; (968) NASA; (969) NASA; (970) NASA; (971) NASA; (972) NASA; (973) NASA; (974) NASA; (975) NASA; (976) NASA; (977) NASA; (978) NASA; (979) NASA; (980) NASA; (981) NASA; (982) NASA; (983) NASA; (984) NASA; (985) NASA; (986) NASA; (987) NASA; (988) NASA; (989) NASA; (990) NASA; (991) NASA; (992) NASA; (993) NASA; (994) NASA; (995) NASA; (996) NASA; (997) NASA; (998) NASA; (999) NASA; (1000) NASA; (1001) NASA; (1002) NASA; (1003) NASA; (1004) NASA; (1005) NASA; (1006) NASA; (1007) NASA; (1008) NASA; (1009) NASA; (1010) NASA; (1011) NASA; (1012) NASA; (1013) NASA; (1014) NASA; (1015) NASA; (1016) NASA; (1017) NASA; (1018) NASA; (1019) NASA; (1020) NASA; (1021) NASA; (1022) NASA; (1023) NASA; (1024) NASA; (1025) NASA; (1026) NASA; (1027) NASA; (1028) NASA; (1029) NASA; (1030) NASA; (1031) NASA; (1032) NASA; (1033) NASA; (1034) NASA; (1035) NASA; (1036) NASA; (1037) NASA; (1038) NASA; (1039) NASA; (1040) NASA; (1041) NASA; (1042) NASA; (1043) NASA; (1044) NASA; (1045) NASA; (1046) NASA; (1047) NASA; (1048) NASA; (1049) NASA; (1050) NASA; (1051) NASA; (1052) NASA; (1053) NASA; (1054) NASA; (1055) NASA; (1056) NASA; (1057) NASA; (1058) NASA; (1059) NASA; (1060) NASA; (1061) NASA; (1062) NASA; (1063) NASA; (1064) NASA; (1065) NASA; (1066) NASA; (1067) NASA; (1068) NASA; (1069) NASA; (1070) NASA; (1071) NASA; (1072) NASA; (1073) NASA; (1074) NASA; (1075) NASA; (1076) NASA; (1077) NASA; (1078) NASA; (1079) NASA; (1080) NASA; (1081) NASA; (1082) NASA; (1083) NASA; (1084) NASA; (1085) NASA; (1086) NASA; (1087) NASA; (1088) NASA; (1089) NASA; (1090) NASA; (1091) NASA; (1092) NASA; (1093) NASA; (1094) NASA; (1095) NASA; (1096) NASA; (1097) NASA; (1098) NASA; (1099) NASA; (1100) NASA; (1101) NASA; (1102) NASA; (1103) NASA; (1104) NASA; (1105) NASA; (1106) NASA; (1107) NASA; (1108) NASA; (1109) NASA; (1110) NASA; (1111) NASA; (1112) NASA; (1113) NASA; (1114) NASA; (1115) NASA; (1116) NASA; (1117) NASA; (1118) NASA; (1119) NASA; (1120) NASA; (1121) NASA; (1122) NASA; (1123) NASA; (1124) NASA; (1125) NASA; (1126) NASA; (1127) NASA; (1128) NASA; (1129) NASA; (1130) NASA; (1131) NASA; (1132) NASA; (1133) NASA; (1134) NASA; (1135) NASA; (1136) NASA; (1137) NASA; (1138) NASA; (1139) NASA; (1140) NASA; (1141) NASA; (1142) NASA; (1143) NASA; (1144) NASA; (1145) NASA; (1146) NASA; (1147) NASA; (1148) NASA; (1149) NASA; (1150) NASA; (1151) NASA; (1152) NASA; (1153) NASA; (1154) NASA; (1155) NASA; (1156) NASA; (1157) NASA; (1158) NASA; (1159) NASA; (1160) NASA; (1161) NASA; (1162) NASA; (1163) NASA; (1164) NASA; (1165) NASA; (1166) NASA; (1167) NASA; (1168) NASA; (1169) NASA; (1170) NASA; (1171) NASA; (1172) NASA; (1173) NASA; (1174) NASA; (1175) NASA; (1176) NASA; (1177) NASA; (1178) NASA; (1179) NASA; (1180) NASA; (1181) NASA; (1182) NASA; (1183) NASA; (1184) NASA; (1185) NASA; (1186) NASA; (1187) NASA; (1188) NASA; (1189) NASA; (1190) NASA; (1191) NASA; (1192) NASA; (1193) NASA; (1194) NASA; (1195) NASA; (1196) NASA; (1197) NASA; (1198) NASA; (1199) NASA; (1200) NASA; (1201) NASA; (1202) NASA; (1203) NASA; (1204) NASA; (1205) NASA; (1206) NASA; (1207) NASA; (1208) NASA; (1209) NASA; (1210) NASA; (1211) NASA; (1212) NASA; (1213) NASA; (1214) NASA; (1215) NASA; (1216) NASA; (1217) NASA; (1218) NASA; (1219) NASA; (1220) NASA; (1221) NASA; (1222) NASA; (1223) NASA; (1224) NASA; (1225) NASA; (1226) NASA; (1227) NASA; (1228) NASA; (1229) NASA; (1230) NASA; (1231) NASA; (1232) NASA; (1233) NASA; (1234) NASA; (1235) NASA; (1236) NASA; (1237) NASA; (1238) NASA; (1239) NASA; (1240) NASA; (1241) NASA; (1242) NASA; (1243) NASA; (1244) NASA; (1245) NASA; (1246) NASA; (1247) NASA; (1248) NASA; (1249) NASA; (1250) NASA; (1251) NASA; (1252) NASA; (1253) NASA; (1254) NASA; (1255) NASA; (1256) NASA; (1257) NASA; (1258) NASA; (1259) NASA; (1260) NASA; (1261) NASA; (1262) NASA; (1263) NASA; (1264) NASA; (1265) NASA; (1266) NASA; (1267) NASA; (1268) NASA; (1269) NASA; (1270) NASA; (1271) NASA; (1272) NASA; (1273) NASA; (1274) NASA; (1275) NASA; (1276) NASA; (1277) NASA; (1278) NASA; (1279) NASA; (1280) NASA; (1281) NASA; (1282) NASA; (1283) NASA; (1284) NASA; (1285) NASA; (1286) NASA; (1287) NASA; (1288) NASA; (1289) NASA; (1290) NASA; (1291) NASA; (1292) NASA; (1293) NASA; (1294) NASA; (1295) NASA; (1296) NASA; (1297) NASA; (1298) NASA; (1299) NASA; (1300) NASA; (1301) NASA; (1302) NASA; (1303) NASA; (1304) NASA; (1305) NASA; (1306) NASA; (1307) NASA; (1308) NASA; (1309) NASA; (1310) NASA; (1311) NASA; (1312) NASA; (1313) NASA; (1314) NASA; (1315) NASA; (1316) NASA; (1317) NASA; (1318) NASA; (1319) NASA; (1320) NASA; (1321) NASA; (1322) NASA; (1323) NASA; (1324) NASA; (1325) NASA; (1326) NASA; (1327) NASA; (1328) NASA; (1329) NASA; (1330) NASA; (1331) NASA; (1332) NASA; (1333) NASA; (1334) NASA; (1335) NASA; (1336) NASA; (1337) NASA; (1338) NASA; (1339) NASA; (1340) NASA; (1341) NASA; (1342) NASA; (1343) NASA; (1344) NASA; (1345) NASA; (1346) NASA; (1347) NASA; (1348) NASA; (1349) NASA; (1350) NASA; (1351) NASA; (1352) NASA; (1353) NASA; (1354) NASA; (1355) NASA; (1356) NASA; (1357) NASA; (1358) NASA; (1359) NASA; (1360) NASA; (1361) NASA; (1362) NASA; (1363) NASA; (13

54

35

30

What causes antibiotic resistance?

JESSIE FORD, M.D.

Antibiotic resistance is a good example of natural selection. Exposure to antibiotics increases selective pressure in bacterial populations, boosting the percentage of resistant bacteria, with new bacterial generations inheriting resistance genes. Bacteria can sometimes pass on resistance by sharing genetic material with each other. They can also become resistant following

spontaneous changes to their genes. Some gene mutations allow bacteria to produce enzymes that inactivate antibiotics. Others change their outer structure so that antibiotics can't gain access. Some bacteria even develop pumping mechanisms to expel antibiotics. Frequent and misuse of antibiotics has exacerbated the problem of antibiotic resistance. **EM**

Here, the wall of a bacterial cell (top) pumps antibiotics (green) out of the cell.

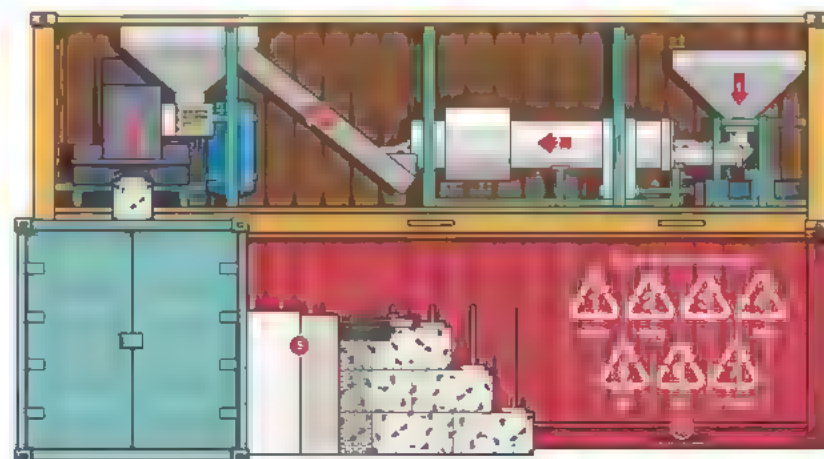
What's the inside of a kangaroo's pouch like?

DAVID SIMPSON, M.D.

Newborn joos are skin wrinkled, pink, and squishy. They crawl for a few days to the warmth and safety of their mothers' cosy pouch. The sticky pouch is strechy and slightly sticky and opens horizontally. It's warm and moist, like a baby's skin. The pouch is lined with a certain type of bacteria that provides a certain type of protection. The pouch is a very adaptive environment. The joos go through several stages of their development: they are born and then mothers have to clean their babies' nuzzles to ensure it doesn't become sticky and unhygienic. They do this by licking the pouch to remove dirt, feces and urine – a true labour of love. **EM**

RECYCLED PLASTIC BUILDING BRICKS

Technology start-up ByFusion is currently developing machinery that can transform any waste plastic into building blocks



1 Plastic rubbish is put into the machine

2 The rubbish moves along into a shredder that cuts the plastic into smaller pieces

3 The plastic is then mixed with superheated water and compressed

4 The bricks emerge from the machine and can be used for building

5 The bricks can be fixed together with metal rods to create structures, before being coated with chicken wire and mortar

6 Any plastics can be used

McMurdo Station in Antarctica can support around 1,200 people at a time

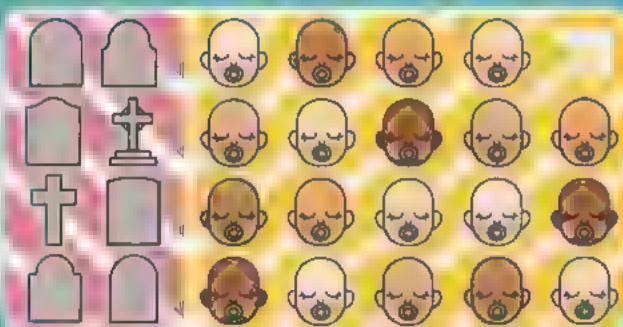
What time zones are used at the North Pole and South Pole?

GARY DIMEEN, M.D.

The rotation of the Earth means that time zones are created by the lines of longitude connecting the two poles. But, (the poles themselves are) these lines converge, meaning, that wherever the poles are, in all the time zones are the same. In practice, polar explorers and scientists simply choose whatever time zone is most convenient. Those working at McMurdo Station in Antarctica, for example, have chosen to use New Zealand time. **EM**

What is the current death/birth rate ratio in the world per year?

ANTHONY PERRY USA



According to the World Bank, for every 1,000 people in the world, an average of 7,740 people will die each year and 19,549 will be born. That's a ratio of about 2.3 births for every death. Those figures are from 2014 but both are showing at similar rates, so the ratio hasn't changed much in the last 10 years or so.

HEAD TO HEAD



MO FARAH

VS



USAIN BOLT

| | | |
|-------------|---------------------|---------------------|
| 175m | HEIGHT | 195m |
| 60kg | WEIGHT | 94kg |
| 4 | OLYMPIC GOLD MEDALS | 8 |
| 12.98s | 100m | 9.58s |
| 3min 56.49s | MILE | 4min 30s (estimate) |

Usain Bolt is the fastest human in the world, but only up to 200m. His huge legs, packed with fast-twitch muscle fibres, allow explosive acceleration but they can't sustain prolonged

aerobic exertion, making them dead weights over longer distances. Usain Bolt has never actually run a mile, but most experts think he'd struggle to get a time under 4min 30s.

What is the deepest lake on Earth?

ELLIE PEARSON NORTHAMPTON

This title goes to 1,642m-deep Lake Baikal, which is located in southern Siberia. The lake is part of an ancient tectonic basin that has formed as the planet's crust slowly pulls apart. It has around 22% of the world's surface freshwater, because of its isolation and age have led to the evolution of an unusual ecosystem containing many plants and animals that are unique to the area. When winter rolls around, a thick layer of ice can form on the lakes surface, trapping many bubbles released from a gas spring in the chilly depths.



The water in Lake Baikal is very clear, so it is possible to see to a depth of 40m from the surface.

Love our Q&A pages? Follow our Twitter feed @sciencefocusQA

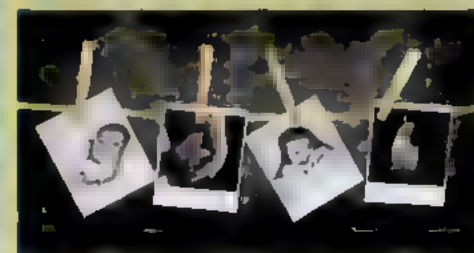
Why are human brains so big?

LEIGH ALLEN, GLASGOW

One possibility is that large brains are social. The person that can make music and art, or tell stories, may be more attractive to potential mates. But in the 1990s, anthropologist Robin Dunbar suggested that humans might also need large brains to keep track of their complicated social lives. Human social circles normally comprise around 150 people, compared with 50 for chimpanzees. Larger social groups have exponentially more interrelationships and our survival and success depends on being able to react to and predict the behaviour of our peers. Related to this is the idea of social dominance. Once our ancestors had begun to master their environment, their biggest threats were other humans. Leadership tussles within and between tribes favoured smarter humans much more than those that were just stronger. **tv**

Why can't we remember early life?

KAREN EVANS, LIL



Our inability to remember anything from before the age of three or four is referred to as infantile amnesia and it's still fairly mysterious. We do know that infants can form long-term memories, chat to a three-year-old about past events and you'll see for yourself. In fact, one study

showed that three-year-olds had a memory of an adult they'd met just once when they were aged one. But for some reason, likely related to the immaturity of infant memory processes, our earliest memories are lost by the time we're about seven years of age. **q**

WHO REALLY INVENTED?

THE TELESCOPE



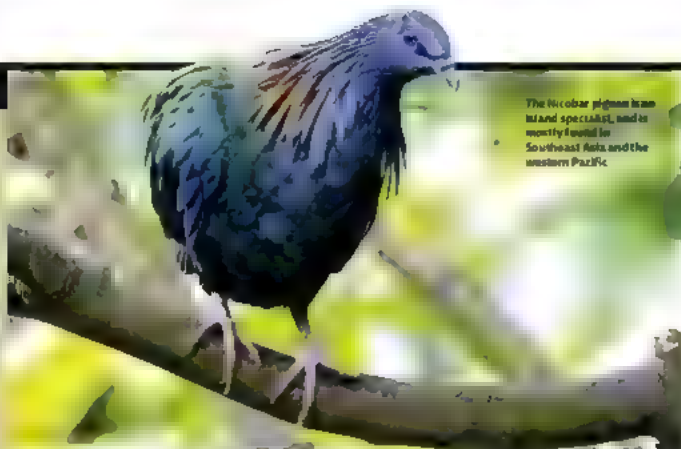
HANS
LIPPERSHEY

LEONARD
DIGGES*

In 1992, a telescope built by the British astronomer and historian Collin Ronan was shown on *The Sky At Night*. Telescopes have been vital to science since Dutch spectacle maker Hans Lippershey patented the now-familiar arrangement of lenses in 1608.

But what made Ronan's telescope different was that it was built to a design pre-dating Lippershey's by decades. Ronan claimed that an Elizabethan surveyor named Leonard Digges had found a combination of a glass lens and curved mirror that also made distant objects appear closer. Descriptions of the device began to circulate around 1570, and its potential military use prompted Lord Burghley, chief adviser to Elizabeth I, to commission a report. After discovering this manuscript in the British Library, Ronan built the device, and suggested that it had a claim to being the first telescope. He also suggested Digges's son, Thomas, had used it to observe the sky years before Galileo. Ronan's claim has failed to convince historians, however. They argue that Elizabethan technology was not capable of making the optical components to the required quality and that the telescope is too awkward to use in any case. So the consensus remains that Lippershey is the originator of the first working telescope. **AM**

*No images of Leonard Digges are available



The Nicobar pigeon is an island specialist, and is mostly found in Southeast Asia and the western Pacific

What is the dodo's closest living relative?

PIPPA NEILSON, AT A PANS

The dodo's closest relative was the Rodrigues solitaire, a large bird that lived on the island of Rodrigues in the Indian Ocean. But that's also extinct. Those two formed their own group which was equally related to all pigeons. So there isn't a single living species the dodo was closest to. Their group

branched off from the pigeon family before the pigeon family radiated. Some records (but *not* the Nicobar pigeon) list the Nicobar pigeon as the closest living relatives of the dodo. This is based on genetic comparison, which is more reliable than inferring relationships from physical characteristics. **AP**

What's the neurological difference between anaesthesia and sleep?

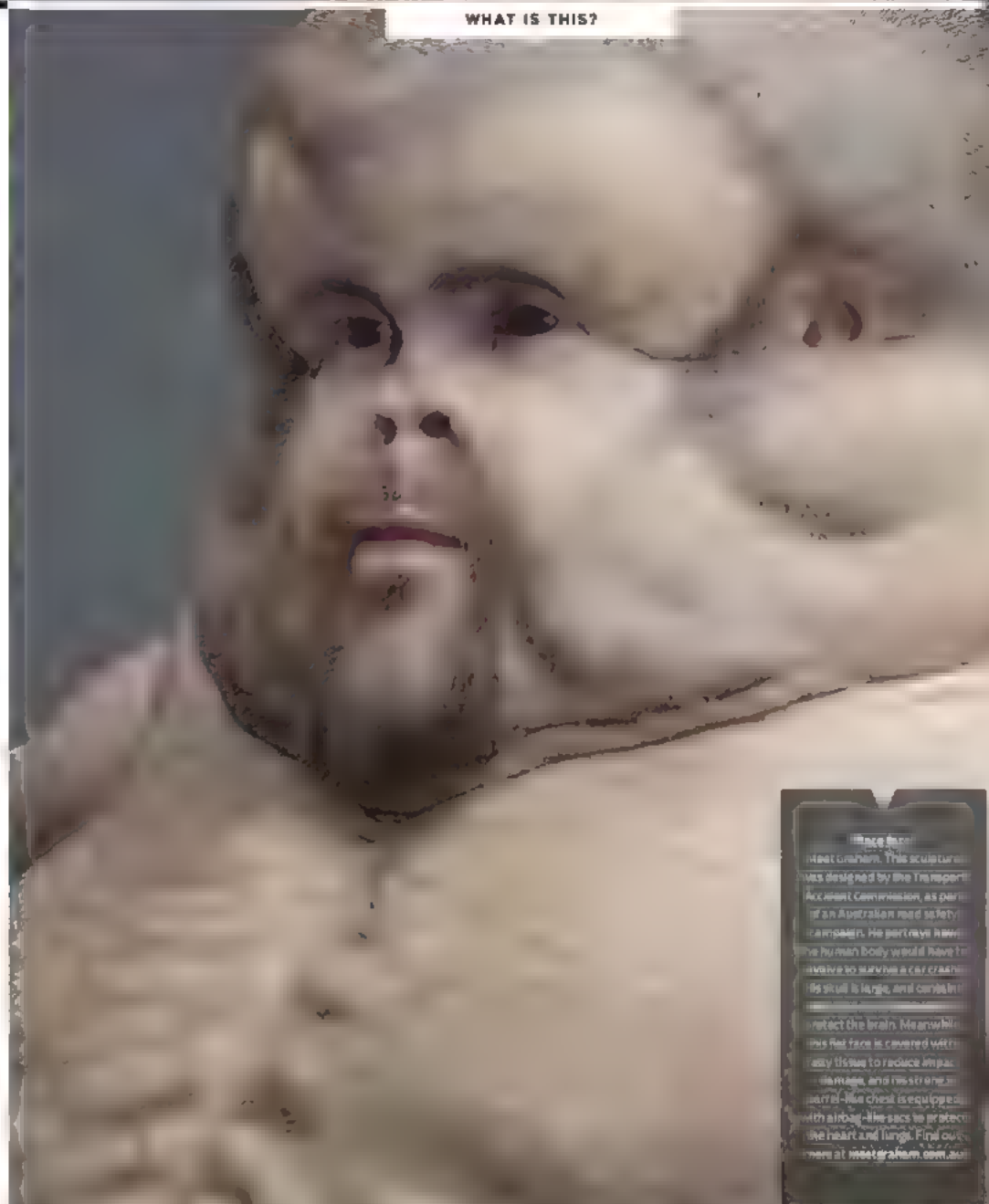
SOPHIA WAN, CROYDON

If a neuroscientist used electroencephalography (EEG) to record your brain's electrical activity while you were under anaesthesia, the results would look different from how they appear when you are sleeping. In fact, your brain waves under anaesthesia would more closely resemble those seen were you to have the terrible misfortune of falling into a coma after brain illness or injury. Doctors often tell surgery patients that they will be 'put to sleep' during the operation, but in terms of the neurological effects of the anaesthesia, it would be more accurate (and more unsettling) to tell them that they will be put into a reversible coma. **Q**



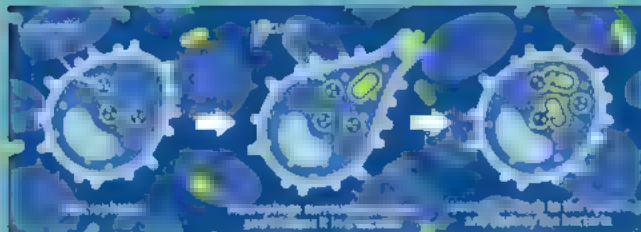
PHOTO: GETTY IMAGES/ACCIDENT INVESTIGATION

WHAT IS THIS?



Place this: Meet Graham. This sci-fi car crash test dummy was designed by the Transport Accident Commission, as part of an Australian road safety campaign. He portrays how the human body would have to survive a car crash. His skull is large, and contains a brain that's designed to protect the brain. Meanwhile, his face is covered with a layer of foam to reduce impact damage, and his torso is a steel cage. His chest is equipped with airbag-like sacs to protect the heart and lungs. Find out more at roadtest.dummies.com.au

Why do you take longer to read as you age?



Are self-driving cars any good at parking?

PAT WARD HE ERFELD

The new FF91 electric car by Faraday Future is advertised as self-parking so it's always perfect by saving two extra seconds during its big, average, 10.68207. That's because automated parking is improving. The latest cars of 2017 will tell you where a gap is big enough, will position themselves correctly and can do

perfect parallel parking all by themselves. You don't even need to be inside the car. However, if you want the most secure way of parking, try a robotic garage that moves your car like a train of cars. One such already in operation at the The Palais Coburg Hotel, Vienna, Austria. ☐



WHAT CONNECTS...

FIRST CLASS POST AND FALCON 9?



1.

In 1810, Heinrich von Kleist proposed packing letters into artillery shells and firing them across the countryside. His plan would have allowed mail to be carried across a relay of artillery batteries, covering 300km in half a day.

2.

Friedrich Schlegel was the first to use a rocket to deliver mail in 1931. His V-7 rocket delivered 107 postcards between two Austrian towns 2km apart.



3.

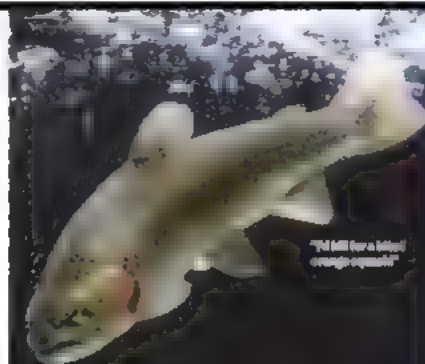
In 1959, the US Postal Service trialled mail delivery with a Regulus cruise missile. The postmaster general predicted that regular rocket mail deliveries would be running before humans reached the Moon.

4.

Rocket deliveries haven't taken off yet, but SpaceX has suggested using Falcon 9 rockets to send cargo from New York to Tokyo in 25 minutes.



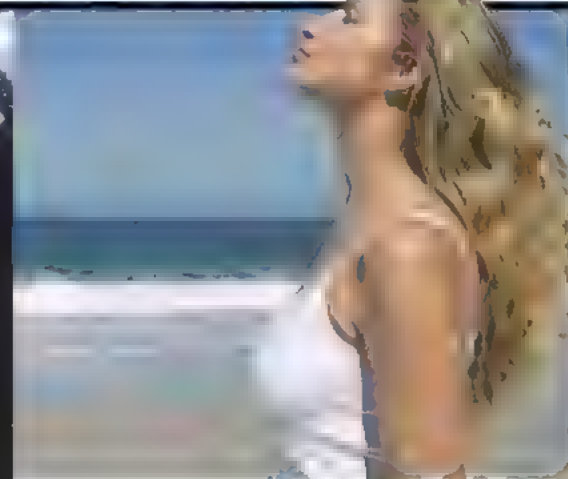
PHOTOS: GETTY IMAGES; ILLUSTRATIONS: BAMA/TOFF



Do fish drink?

ANGELA COOM, LONDON

Depending on where they live, fish either drink a lot or pee a lot. In the sea, a fish's body is less salty than its surroundings, so it loses water across its skin and through its gills via osmosis. To stop themselves dehydrating, marine fish drink masses of seawater and produce a trickle of concentrated urine. When migrating fish like trout and salmon move into rivers and lakes, they face the opposite problem and risk absorbing too much water until eventually their cells begin to swell and burst. To avoid this, they switch from being heavy drinkers to plentiful uriners. ☐



Why does the sea smell like the sea?

AOLINE SMITH, LONDON

Saltwater by itself doesn't have any smell, but the things that live in it certainly do. The water's a bit sulphury-smell is mainly kept in check by bacteria as they digest dead phytoplankton. A new tide will also smell a bit like a cat's paws, tyrosines, which are sex pheromones produced by seaweed eggs – a trait the sperm. And on top of that, there's a bit of a smell of the sea, which is actually the bromophenols produced by marine worms and algae. ☐

Will e-learning replace teachers?

EDWARD SEYMOUR, MOVE

Online courses and interactive forums are becoming important in many countries as they allow students to gain access to a greater depth and breadth of information than a teacher may be able to provide. At Georgia Institute of Technology, Prof. Ashok Goel went one step further. He created a course in knowledge-based artificial intelligence and created an AI teaching assistant to respond to forum posts from his students. Goel only admitted to them it was an AI after four months. "blowing their minds." But studies also show that interaction with real people is still vital to enable children to develop normally. Children who use computers excessively show a measurable deficiency in social skills. ☐



PHOTOS: NASA/GETTY

Is the flag still on the Moon?

HARRIET FYFE, FALKLAND ISLANDS



Six flags were planted on the Moon – one for each Apollo landing. Apollo 11's flag was too close to the lander and was knocked over by the rocket exhaust when Armstrong and Aldrin took it again. But high-resolution images from the Lunar Reconnaissance Orbiter show that the other five are still standing. The flags were made of ordinary nylon though, so they have all long since been bleached white by the Sun. **W**



Do any other animals get male pattern baldness?

CHRIS SAUNDERS, LIMEHURST

The sensitive response to androgen – a sex hormone – is an important feature of human hair. At puberty, hair grows in places where we had no hair as we age, changes in hormonal levels can lead to thinning hair in both men and women, and to baldness in some. But humans are not the only animals to experience this. It happens in chimps

and stump-tail and macaques in nearly the same way. And mice, rats, hamsters, rabbits and sheep become sensitive to fur loss when their androgen levels were manipulated in the laboratory. There was even a report in which wattled starlings in the wild displayed a bald scalp in response to natural changes in androgen levels. **W**

QUESTION OF THE MONTH

Why do the centres of galaxies contain black holes?

ADAM KING, HUGBOURNE

Since the 1960s, astronomers have uncovered evidence that most galaxies contain so-called supermassive black holes at their cores. With masses between a million and a billion times that of the Sun, these leviathans first revealed their presence in so-called quasars – distant galaxies with cores so luminous the only plausible source of power is the intense gravity of black holes devouring matter. Since then, studies of stellar orbits have shown that even relatively tranquil galaxies like our own Milky Way harbour hefty black holes. Their origin remains a mystery, however. They may have been created by the gravitational collapse of giant gas clouds from which galaxies were formed, or from the merger of many smaller black holes over time. Another possibility is that one simply grew over billions of years by steadily devouring orbiting stars. **W**

WINNER!

Adam King wins two Blink security cameras. These monitors are temperature- and motion-sensitive and let you check on your home instantly via the Blink app (£109.99 each, blinkforhome.co.uk).

NEXT ISSUE:

Why aren't all planets rocky?

Why does skin wrinkle with age?

Will time ever end?

Q
U
I
S
T
O
N

SCIENCE TEACHERS BECOME EXAMINERS OR MODERATORS WITH CCEA



Opportunities available as CCEA science examiners and moderators

A supply of well-trained and motivated examiners and moderators is vital to the health of our entire education system. That's why we want you to become involved in the process of marking and moderating examinations and assessments with CCEA.

www.ccea.org.uk



AQUILA Magazine: a feast of facts & fun!

From **Stephen Hawking** to **Harry Potter**, this exuberant and inspiring publication is designed to capture young readers' interest in all aspects of **Science, Arts and General Knowledge**. Ideal for 8 – 12 year olds, it tackles serious educational topics with humour and intelligence, encouraging children to think creatively and ask questions about the world.

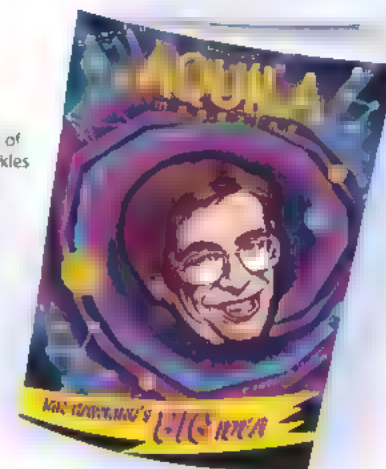
*"... Advanced & Philosophical,
Curious & Puzzling"*

RICHARD ROBINSON,
Review, The New York Times



HAPPY BIRTHDAY ALL YEAR!

What could be more fun than a gift that keeps coming through the letterbox every month? If you wish the first issue can be dispatched in time for the special day along with your gift message.



March Issue: Mr Hawking's children

This month **AQUILA** investigates the life and space-times of the UK's science superstar. Children can go black hole hunting, investigate the concept of **space and time**, and stretch their brains to the **outer limits**. PLUS: Lucy Hawking tells us what it is like to have a genius for a dad.

See sample issue and more info about **AQUILA** at:
www.AQUILA.co.uk Tel: 01323 431313

OUT THERE

WHAT WE CAN'T WAIT TO DO THIS MONTH

PHOTOGRAPHY



01

STARGAZING LIVE
LIVE ON BBC TWO, 28-30 MARCH

EXPLORE THE SOUTHERN SKY

Stargazing Live returns this March, but with a twist – Prof Brian Cox and Uma O Briain will be broadcasting live from Australia. For three nights they'll be camped out deep in the Outback, beneath some of the darkest skies in the world.

It's the perfect time of year for stargazing Down Under, with the bulging heart of the Milky Way directly overhead and the planet Saturn swinging into view with its famous rings. In the southern sky, familiar objects such as the Moon and the Orion constellation appear upside down, while we'll see famous stars and constellations such as the Southern Cross, Scorpius and Alpha Centauri that are rarely, if ever, visible from the UK.

Meanwhile, we'll hear haunting tales of Aboriginal astronomy, some born of the wildlife that stalks stargazers in the Outback, and find out why Australia is in the firing line for contact from aliens. Maybe they just like warm beer...

DON'T MISS

STARGAZING LIVE

Are you a beginner to astronomy? Pick up this special edition from the team behind *Sky At Night Magazine*. On sale now.



02 EXPERIMENT WITH OUR FOOD

Want to cook up a delicious meal? It's not just about the food. We chat to psychologist PROF CHARLES SPENCE about the strange science of gastraphysics

What exactly is gastraphysics?

It's a combination of gastronomy and psychophysics, which involves the scientific study of how our experience of food and drink is affected by our senses and our surroundings, not just the food itself. It's a small but growing area of research which brings together psychologists, neuroscience, marketers, chefs, product designers and even musicians.

So what kinds of things can affect our sense of taste?

Pretty much everything! From the colour and shape of the plates to the weight and material of the cutlery, through to the shape of the table and the feel of the chair you're sitting on. Then there's the number of people you're with, the mood you're in, the lighting and background music in the restaurant, and memories associated with the food. When you put all these factors together, it adds up to a lot.

Just how important are these effects?

It's hard to say exactly how much of the taste is down to the food and how much is the 'everything else'. But Paul Bocuse, one of France's foremost chefs, has said that more than half of the experience of what he serves is the 'everything else'. Obviously some things matter more than others – the background music is going to have more of an impact than the shade of paint on the restaurant walls, for instance. A number

What's the most surprising way in which our taste can be influenced?

It's the idea of **cross-modal transfer**, which uses sounds to change the taste of food. You can add as much as 15 per cent extra sweetness, sourness, or bitterness to a food simply by playing the right sort of music. We've created music to enhance sweetness (high-pitched and tinkling) and bitterness (low-pitched and brassy), and we also have music for sour, umami, and spicy foods. Working with the Michelin-starred chocolatier Dominique Persoone in Belgium, we even showed that if we played 'creamy' music (slow and legato) in his stores we could add extra creaminess to his chocolate.

Neuroscientists have found direct connections in the mouse brain between the senses of smell and sound, so it might be that this occurs in humans too. Sensory seasoning is already being used to enhance meals in fine restaurants and culinary events, but we could also see it being used in everyday life, for example, playing 'sweet' music so that we're happy with less sugar in our food.

How is our sense of taste influenced by the colour of the plate?

There are probably two or three things happening here. It might be to do with the contrast between the colour of the plate and the colour of the food – our brain will find it harder to pick out porridge (and process its taste) when served in a white bowl, for instance. A number



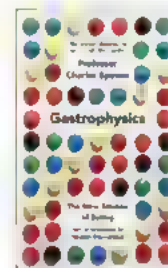
This duck and beetroot dish was created by Charles Spence's kitchen. Theory if viewed upside down Picasso's face can be seen in the meal.

"Studies show that serving food off red plates can suppress appetite"

of studies also show that serving food off red plates can suppress appetite, possibly because this is the colour of danger and 'stop'. And there's also the effect of our expectations. If we're used to eating ice cream from a round white bowl, then our brain will already expect something sweet when we're served food in a similar dish.

What's the most innovative use of gastraphysics you've seen?

There's a lot happening in the world of cutlery design. Heston Blumenthal's restaurant The Fat Duck is currently serving a dish called Counting Sheep, which comes with a fluffy, weighted spoon that smells of baby powder to enhance the eating experience. We've found that food tends to taste better with heavier cutlery – possibly because we associate weight with quality.



GASTROPHYSICS

BY CHARLES SPENCE
OUT 30 MARCH CE 4.99, VIKING



+ PROF SPENCE'S FIVE TIPS TO TRY AT HOME



THINK ABOUT THE MUSIC

To bring out the authenticity of a dish, try playing ethnically appropriate background music (such as sitar music while eating a curry). If you want to bring out the sweetness of a dessert, go for some tinkling piano music.



TURN OFF THE TV

Turning off the TV makes us more mindful about what we're eating. People have been shown to eat up to 30 per cent more when the TV is on.



EXPERIMENT WITH PLATEWARE

Don't just go for round, white plate. Try serving something on a slate, a plank of wood, or even out of a plant pot. Or simply change the plate colour. These will all affect your food's taste.



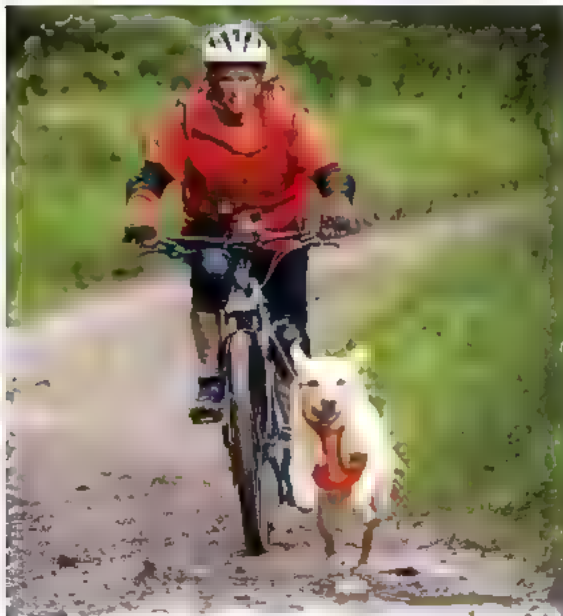
MAKE AN IMPRESSION

We're only eating for a few moments, so a lot of the pleasure is in the memory of a meal. Create surprise by combining unexpected flavours and textures (remember Heston's bacon and egg ice cream?).



DITCH CUTLERY

More and more restaurants are getting rid of cutlery. We didn't evolve to eat with cold stainless steel, and eating with our hands adds another sense to the experience. Just don't try it with risotto.



03

ME AND MY DOG: THE ULTIMATE CONTEST
8.01.17-01.04.17 CHECK RACING TIMESCELEBRATE OUR
DOGS

The bond between man and dog goes back thousands of years, so it was perhaps only a matter of time before we had a TV show dedicated to this enduring relationship. *Me And My Dog* will see eight people and their dogs competing in a series of physical and mental challenges, designed to find out who has the closest relationship with their canine companion.

Presented by Chris Packham, over four weeks, the contest takes place on vast the rugged terrain of the Lake District, with disciplines including paddleboarding, canine parkour, and a tethered cross-country run. Along the way, we'll learn about the science of dog training, and find out just what makes the human-pooch bond so strong.

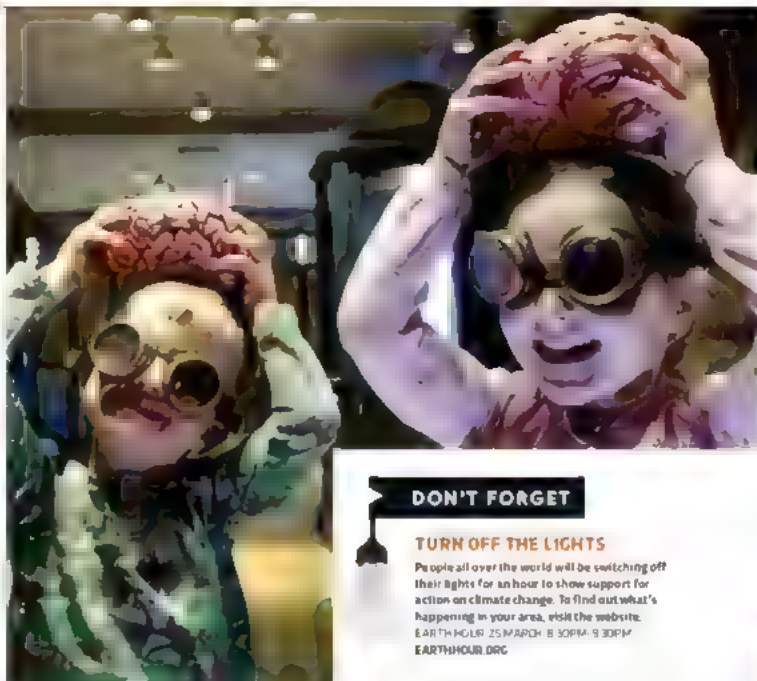
04

EDINBURGH
INTERNATIONAL
SCIENCE FESTIVAL
1-5 APRIL
SCIENCEFESTIVAL.CO.UK

GO NORTH

Scotland's capital city is set to become a hive of science-themed activity this April, with the return of the Edinburgh International Science Festival. The theme of this year's festival is 'get connected' and there are more than 250 events lined up for children and adults.

The City Art Centre will be transformed into a science playground, offering families the chance to create their own coral creatures, build humanity's first Mars colony and design their own alien. Meanwhile, there are other happenings across the city, from science theatre and brand new exhibitions to a hands-on experimentalism and a gag from sample-based science projects. Public Service Broadcasting. Check out the festival programme at sciencefestival.co.uk/whats-on.



DON'T FORGET

TURN OFF THE LIGHTS

People all over the world will be switching off their lights for an hour to show support for action on climate change. To find out what's happening in your area, visit the website. EARTH HOUR: 25 MARCH 8.30PM-9.30PM. EARTHHOUR.ORG

Kew

Kew is more
than just
a garden.We're
safeguarding
life on Earth.

All our lives depend on plants. Kew's collections, our people and our partnerships help us to make a vital contribution to some of the biggest issues facing the world today. From discovering and conserving plants, to documenting and conducting research into plant diversity and its uses for humanity, we safeguard the very basis of life.

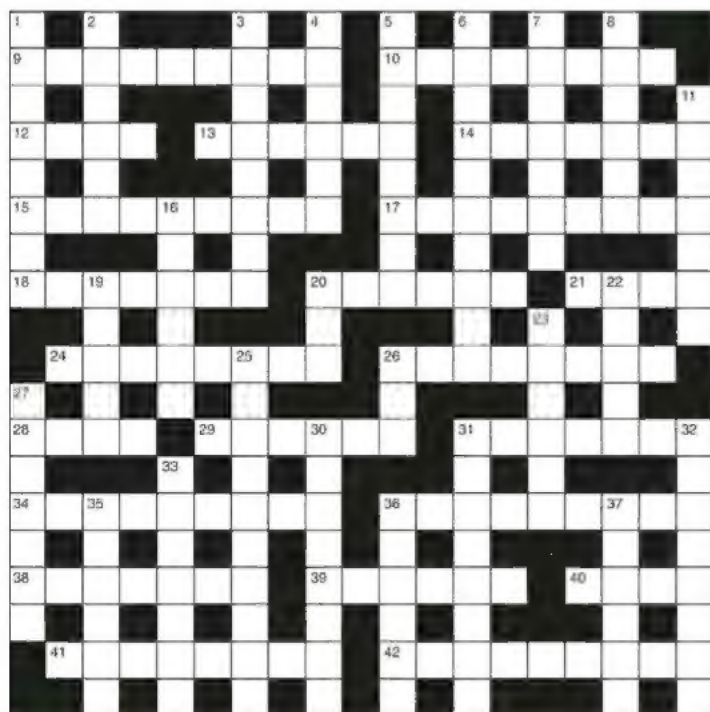
Help safeguard life on Earth by donating today

kew.org/safeguardinglife

The Foundation and Friends of the Royal Botanic Gardens, Kew is a registered charity no. 803426. Registered in England and Wales.

SCIENCE CROSSWORD

GIVE YOUR BRAIN A WORKOUT



ACROSS

- 9 Soldier to gauge an auxiliary variable (9)
 10 Student rings European about hard legal ambiguity (8)
 12 Level of wage increase, say (4)
 13 So nice to have reassessed function (6)
 14 Two follow ceremony east to doomed city (7)
 15 Room to turn and mislay plant structure (9)
 17 Awfully grey scoop about self-levelling device (9)
 18 Try open form of confusion (7)
 20 Sunset captured by fellow German (6)
 21 Old friend gets a stone (4)
 24 Greek hero has a cold and takes additives (8)

- 26 Technophobes did let us work (8)
 28 Curse that may be Hippocratic (4)
 29 Maroon beach (6)
 31 Sue ran behind shopping centre for part of hearing (7)
 34 Daughter organised help in America for dolphin (9)
 36 Developed poor, clear material (9)
 38 Hum bits composed about metal (7)
 39 Skin contains a large binary compound (6)
 40 Spots synonym for reckless (4)
 41 Quickly take erroneous core prediction (8)
 42 Open tidal movement in celestial object (9)

DOWN

- 1 Replicas constructed of respiratory aperture (8)
 2 Country nut (6)
 3 Go to lie about unknown study of causation (8)
 4 Just like a bear, ruins excursion east (6)
 5 Everyone turns green – that produces a reaction (8)
 6 Policeman finds chief a crawler (10)
 7 I'm returning trunk outside shop (7)
 8 Consort lost right to perform in reflected light (6)
 11 Dismiss insect as a beetle (7)
 16 Ideal spot to view Thomas More's vision (6)
 19 Understood to be in Latin (5)
 20 British and American group of conductors (3)
 22 Bit of quiet is heard (5)
 23 Venetian island and river have one voice (6)
 25 Hate talent displayed by quality of changing matter (6, 4)
 26 Guided by a small light (3)
 27 Spanish city has attachment to old graduate (7)
 30 Art-lover sculpted the seat with energy (8)
 31 I'd remain puzzled by line of longitude (8)
 32 Plus arrangement to conceal compound (8)
 33 Church has a cure devised for poet (7)
 35 Left racket to return injury (6)
 36 Ruler of state gets terribly hip (6)
 37 Hardly overdue bringing back optical instrument (6)

ANSWERS

For the answers, visit bit.ly/B8CFocusQW. Please be aware the website address is case-sensitive.

FOCUS MARKETPLACE

To advertise in this space please contact Jenna-Vie Harvey at jenna-vie.harvey@immediate.co.uk or telephone 0117 300 8540

Outdoor Tools to Power your Adventure

Pack a Celestron Elements and never get caught without heat, power or light again.

CELESTRON IS DISTRIBUTED IN THE UK & IRELAND BY DAVID HINDS LIMITED. TRADE ENQUIRIES WELCOME.

Take a Closer Look!

Discover a world of intricate detail with innovative biological, digital and Wi-Fi microscopes and student microscope kits.

CELESTRON® and Elements® are registered trademarks of Celestron Instruments, LLC in the United States and in many other countries around the world. All rights reserved. David Hinds Ltd is an authorized distributor and reseller of Celestron products.

www.celestron.uk.com @David_Hinds_Ltd

365 Astronomy

Discovery for every day!

TELESCOPES, BINOCULARS, SPOTTING SCOPES, MICROSCOPES & A WIDE RANGE OF CCD & DSLR CAMERAS & ASTRO PHOTO ACCESSORIES FOR SCIENTISTS & ENTHUSIASTS

From world leading brands: *Baader, Celestron, Farnax, Moravian Instruments, Skywatcher, Primaluce Lab, ZWO & many more*

Call 020 33 845 187 between 9am - 9pm 7 days a week

www.365astronomy.com

LOOKING TO BE PUBLISHED?

SUBMISSIONS AND SAMPLES WELCOMED. ALL WORK CONSIDERED, NO AGENT REQUIRED.

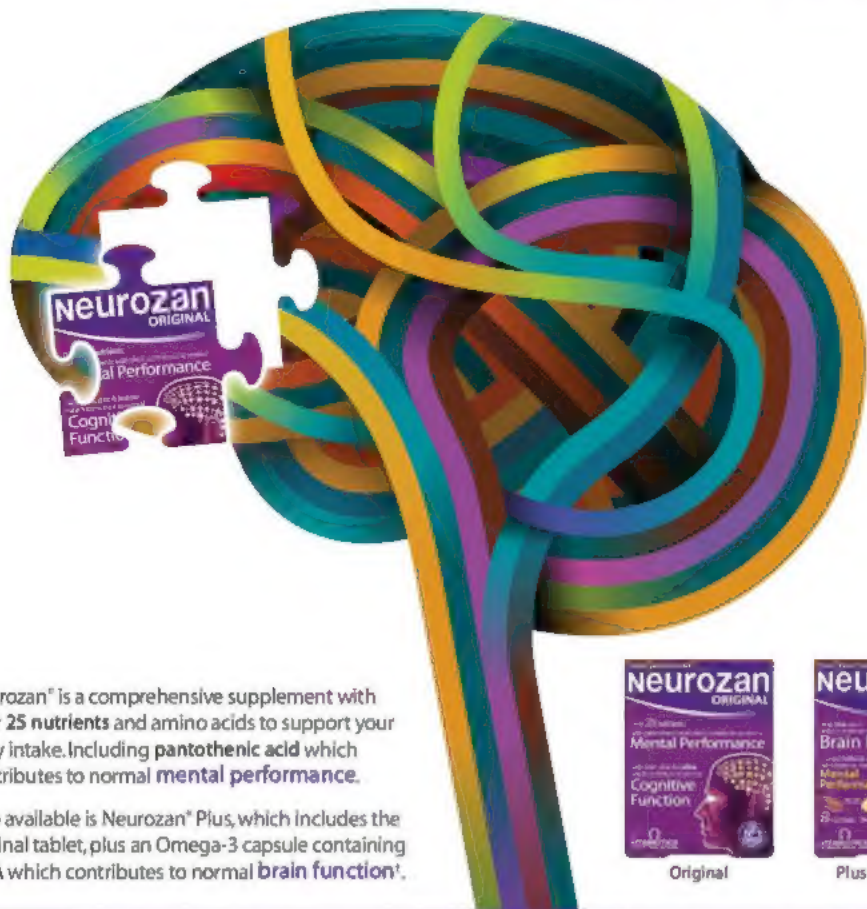
AUSTIN MACAULEY PUBLISHERS LTD.

CGC-33-01, 25 Canada Square
 Canary Wharf, London, E14 5LQ
 Tel: 0207 038 8212
www.austinmacauley.com
mail@austinmacauley.com

FOCUS

To advertise in this space please contact jenna-vie.harvey@immediate.co.uk or telephone 0117 314 8369

piece of mind neurozan®



Neurozan® is a comprehensive supplement with over 25 nutrients and amino acids to support your daily intake. Including pantothenic acid which contributes to normal mental performance.

Also available is Neurozan® Plus, which includes the original tablet, plus an Omega-3 capsule containing DHA which contributes to normal brain function*.



Original



Plus Omega-3

Britain's No.1 Vitamin Company*

*Nielsen GB ScanTrack Total Coverage Value Sales 52 w/e 18th June 2016.

From **Boots**, **Hotland** & **Barrett**, **Tesco**, **Waitrose**, independent pharmacies & health stores, www.neurozan.com

*A beneficial effect is obtained with a daily intake of 250mg DHA.



The ONLY vitamin company to receive The Queen's Award For Innovation



VITABIOTICS
SCIENCE OF HEALTHY LIVING

WE ARE:

Editorial
Editor Daniel Bennett
Production editor Alex Lippman-Southwell
Commissioning editor Jason Condy
Online editor Alex Underhill
Editorial assistant James Lloyd
Science correspondent Richard Heathwell
Contributing editors Emma Bayley, Russell Banks

Art
Art editor Jane Eden
Designer Steve Brown
Picture editor James Cuthbert
Group art editor Susanne Frank

CONTRIBUTORS
Astrid Gough, Alamy, Peter Bentley, Dan Bright, Dean Burnett, Alexandra Chung, Sara Chivers, Stuart Clark, Kate Copland, Charlotte Conley, Brian Cox, Helen Cowie, Emma Davies, Jeff Fawcett, Duncan Green, Alex Gregory, Alister Gunn, Sam Harris, Christian Jarrett, Ross Lincoln, Mark Lorch, Magic Torch, Lisa Moses, James O'Brien, Chris Peck, Helen Pether, Aarshi Prasad, Sean Purcell, Helen Spinks, Kyle Sinker, Lutz Vissler

ADVERTISING & MARKETING
Group advertising manager Tom Drew
Advertising manager Sam Wright
Senior brand & sales executive John Richardson
Brand sales executive Anika Jones
Senior classified executive Emma McManus
Newstrade manager Rob Drisk
Subscriptions director Julia Penfold-Morris
Direct marketing manager Hilary Lane

MOBILE
Product and development director Richard Fennell
Head of apps and digital edition marketing Mark Sumner

ROBOTS
Lawrence Roberts, 0203 070 3020

EDITING & SYNDICATION
Director of licensing and syndication Tim Hudson
International partners manager Anna Brown

PRODUCTION
Production director Sarah Powell
Production coordinator Emily Mounter
Ad services manager Paul Thornton
Ad coordinator Joe Haskon
Ad designer James Grah

PUBLISHING
Publisher James Spence
Publishing director Andy Healy
Managing director Andy Marshall
Chief executive officer Tom Burns
Deputy chairman Peter Higgins
Chairman Stephen Alexander

UK WIDEWIDE, UK PUBLISHING
Director of editorial governance Nicholas Brier
Director of consumer products and publishing Andrew Moulton
Head of UK publishing Chris Kenyon
Publisher Marilyn Thwaites
Publishing coordinator Gail Abrams
Contact UK Publishing at uk@immediate.co.uk
www.immediate.co.uk and publishing.immediate.co.uk

EDITORIAL COMPLAINTS
editorial.complaints@immediate.co.uk

ANNUAL SUBSCRIPTION RATES (INC P&P)
UK/ROF £58.50, Europe & Rest of World £78.50
Rest of World Airmail £88

abc Audit Bureau of Circulations
18,588 (Quarterly Jan-Dec 2016)

IMMEDIATE MEDIA

ABC Focus Magazine is published by Immediate Media Company (UK) Limited under license from BBC Worldwide who help fund the BBC group services.
© Immediate Media Co (UK) Ltd 2017. All rights reserved.
Printed by William Gibbons Ltd.
Immediate Media Co (UK) Ltd accepts no responsibility for loss of or damage to or destruction of any material submitted through advertising agencies carried in this magazine.

NEXT MONTH



MAY ISSUE ON SALE 18 APRIL

PHYSICS

The truth about time

It's a topic that has the greatest minds scratching their heads. What exactly is time? Where does it come from? And in what direction does it flow? Follow us down the rabbit hole...

AI

ROBOTS THAT LEARN

Robots are getting smarter by the week, but just how close are they to the next big leap in their evolution – the ability to learn from humans and think for themselves?



PHOTO: GETTY

WILDLIFE

SAVE THE PANDA?

The giant panda has recently been downgraded from endangered to vulnerable. So is it time to transfer money and resources to conserving other threatened species?



TECHNOLOGY

DRIVERLESS CARS PRIMER

Whether you like it or not, we'll soon be sharing our roads with autonomous vehicles. In fact, your next car could be driverless. Before you buckle up, read our guide to this game-changing technology.



"I worked with one serial killer, a trained butcher, who dismembered people"

Forensic psychologist **Kerry Daynes** talks to **Helen Pilcher** about psychopaths, stalkers and the surreal side of working with serial killers

What do you do?

I've spent a lot of my career working with people who have severe personality disorders, including psychopaths and sexual offenders. It was my job to make them less of a risk.

What's it like working with these people?

It can be surreal. I worked with one serial killer, a trained butcher, who dismembered people. You have to build up a rapport with people in order to work meaningfully with them, so we cooked together. He taught me how to bone a turkey! All along I was aware these were the same skills that he used on his victims.

Which are you more like, Clarice Starling or Cracker?

Neither, these fictional characters are 'profilers', Cracker was an emotionally damaged Scot who tramped all over crime scenes. It's an inaccurate portrayal of what people like me do. But anything that sparks the public's interest in science and psychology is okay in my book.

What was it like the first time you met one of these offenders?

It was a baptism of fire. I was 21 years old, doing research in a high-security prison, interviewing men who had raped and murdered their victims. While it was daunting, I was able to separate myself from it emotionally and get on with the job. In the end, the prison officers were more difficult than the offenders.

How do you mean?

It was an incestuous, institutional male environment. The guards ordered me to remove my shoes because they were 'too sexy'. They even ran a book on who would be the first to sleep with me! Things have moved on since then and I don't work in prisons any more. Forensic psychology is actually a very female world.

Does your professional life ever spill into your private life?

I became the victim of a stalker. He watched me, bought websites in my name and said damaging things about me in public. The police could only issue a harassment warning but I took civil action against him. It stunned me how inadequate the current laws are, but it did give me first-hand knowledge of what it's like to be a victim.

Do you ever think about quitting?

I've worked with the most misogynistic, dangerous men imaginable. It takes its toll. I made a conscious decision a while ago to stop working with them and start working more in general mental health and with victims. I've also branched into the corporate sector.



Do you meet many psychopaths in the business world?

Yes! One in every 100 people are psychopaths and 20 per cent of CEOs score highly on psychopathic traits. Moderate levels of psychopathic-like traits can be useful, as long as they're tempered with compassion and humility. I draw on my unique experiences to teach skills to business leaders.

Kerry Daynes is a consultant psychologist who has worked with some of the most notorious criminals in the UK. Her most recent book is *Is There A Psycho in Your Life?*

DISCOVER MORE

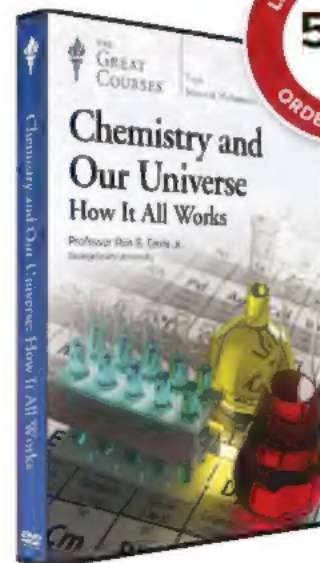
To listen to episodes of *The Life Scientific* with top scientists, visit bit.ly/life_scientific
NEXT ISSUE: JAN ZALASIEWICZ

I think I am going to worry about you. Promise me you'll be okay? I'm pretty resilient. I come from a very stable and 'normal' background; that helps. I also have two enormous dogs, Humphrey and Foxchops. When the complexity and inhumanity of some humans feels a little overwhelming, the simplicity and innocence of a happy dog is a great antidote. ☺

ILLUSTRATION: TIM MCDONAGH



THE
GREAT
COURSES



Understand Chemistry from Particles to Polymers

Our world is ruled by chemistry. It is the study of matter and energy at the scale of atoms and molecules. As the most all-embracing discipline there is, it should be at the top of everyone's list of must-learn subjects.

Chemistry and Our Universe: How It All Works is your in-depth introduction to this vital field, taught through 60 visually engaging half-hour lectures that are suitable for any background or none at all. Covering a year's worth of introductory general chemistry at the college level, plus intriguing topics that are rarely discussed in the classroom, this amazingly comprehensive course requires nothing more advanced than secondary school maths. Your guide is Professor Ron B. Davis Jr., a research chemist and award-winning teacher at Georgetown University. With passion and humour, Professor Davis guides you through the fascinating world of atoms, molecules, and their remarkable interactions, showing you how to think, analyse problems, and predict outcomes like a true expert in the field.

Offer expires 16/05/17

THEGREATCOURSES.CO.UK/6FS
0800 298 9796

Chemistry and Our Universe: How It All Works

Taught by Professor Ron B. Davis Jr.
GEORGETOWN UNIVERSITY

LECTURE TITLES

1. Is Chemistry the Science of Everything?
2. Matter and Measurement
3. Wave Nature of Light
4. Particle Nature of Light
5. Basic Structure of the Atom
6. Electronic Structure of the Atom
7. Periodic Trends: Navigating the Table
8. Compounds and Chemical Formulas
9. Joining Atoms: The Chemical Bond
10. Mapping Molecules: Lewis Structures
11. VSEPR Theory and Molecular Geometry
12. Hybridization of Orbitals
13. Molecular Orbital Theory
14. Communicating Chemical Reactions
15. Chemical Accounting: Stoichiometry
16. Enthalpy and Calorimetry
17. Hess's Law and Heats of Formation
18. Entropy: The Role of Randomness
19. Influence of Free Energy
20. Intermolecular Forces
21. Phase Changes in Matter
22. Behaviour of Gases: Gas Laws
23. Kinetic Molecular Theory
24. Liquids and Their Properties
25. Metals and Ionic Solids
26. Covalent Solids
27. Mixing It Up: Solutions
28. Solubility and Saturation
29. Colligative Properties of Solutions
30. Modelling Reaction Rates
31. Temperature and Reaction Rates
32. Reaction Mechanisms and Catalysts
33. The Back and Forth of Equilibrium
34. Manipulating Chemical Equilibrium
35. Acids, Bases, and the pH Scale
36. Weak Acids and Bases
37. Acid-Base Reactions and Buffers
38. Polyprotic Acids
39. Structural Basis for Acidity
40. Electron Exchange: Redox Reactions
41. Electromotive Force and Free Energy
42. Storing Electrical Potential: Batteries
43. Nuclear Chemistry and Radiation
44. Binding Energy and the Mass Defect
45. Breaking Things Down: Nuclear Fission
46. Building Things Up: Nuclear Fusion
47. Introduction to Organic Chemistry
48. Heteroatoms and Functional Groups
49. Reactions in Organic Chemistry
50. Synthetic Polymers
51. Biological Polymers
52. Medicinal Chemistry
53. Poisons, Toxins, and Venoms
54. Chemical Weapons
55. Tapping Chemical Energy: Fuels
56. Unleashing Chemical Energy: Explosives
57. Chemistry of the Earth
58. Chemistry of Our Oceans
59. Atmospheric Chemistry
60. Chemistry, Life, and the Cosmos

Chemistry and Our Universe: How It All Works
Course no. 1150 | 60 lectures (30 minutes/lecture)

SAVE £60

DVD £114.99 NOW £54.99

£2.99 Postage and Packing
Priority Code: 141159

For over 25 years, The Great Courses has brought the world's foremost educators to millions who want to go deeper into the subjects that matter most. No exams. No homework. Just a world of knowledge available any time, anywhere. Download or stream to your laptop or PC, or use our free apps for iPad, iPhone, Android, or Kindle Fire. Over 600 courses available at www.TheGreatCourses.co.uk.

The Great Courses®, 2nd Floor, Mander House, Mander Centre
Wetherhampton, WY1 3NH. Terms and conditions apply.
See www.TheGreatCourses.co.uk for details.

head & shoulders **MEN
ULTRA**

NEW

UNBEATABLE*

DANDRUFF PROTECTION
DESIGNED FOR MEN



New Head & Shoulders Men Ultra.

Designed for men, its formula with high-performance booster gives unbeatable dandruff protection* and stronger hair**.

Now you are up for any challenge.

*With regular use - versus anti-dandruff shampoos, excluding anti-dandruff shampoos containing selenium. **Strength against breakage.